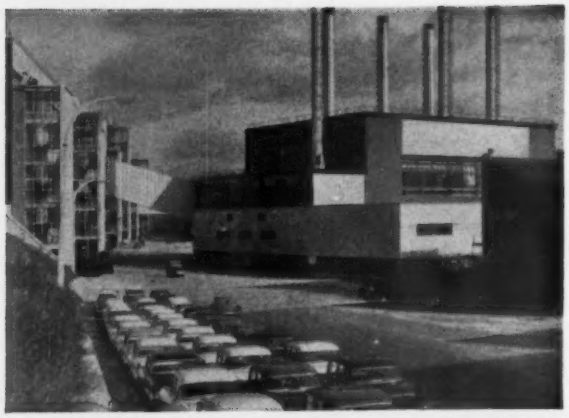
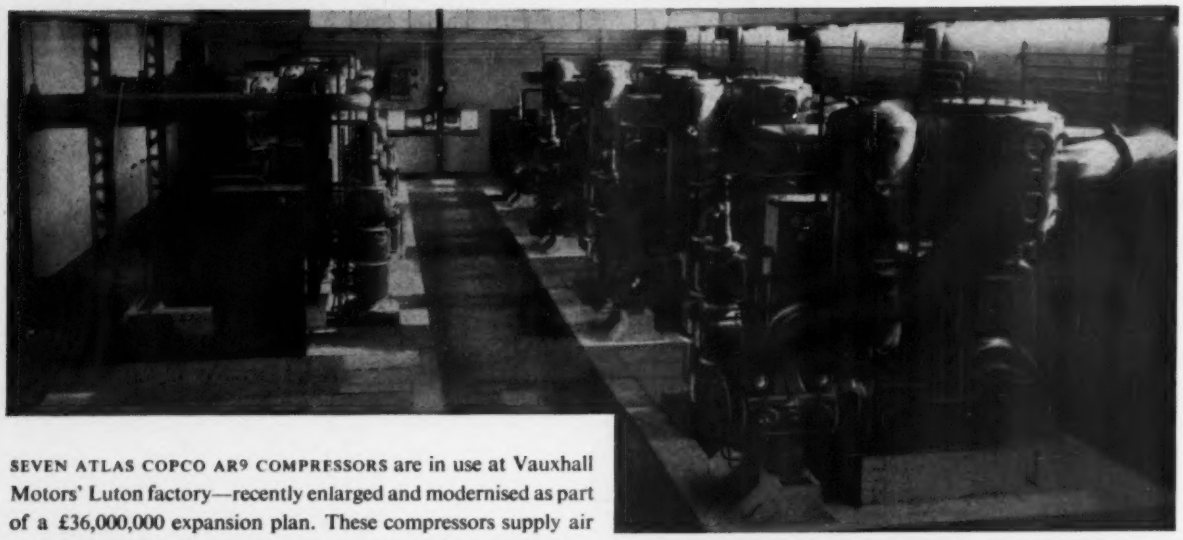
AUTOMOBILE ENGINEER

DESIGN · PRODUCTION · MATERIALS

Vol. 49 No. 6 JUNE 1959 PRICE: 3s. 6d.

Compressed Air at work in Vauxhall's Luton extension





SEVEN ATLAS COPCO AR9 COMPRESSORS are in use at Vauxhall Motors' Luton factory—recently enlarged and modernised as part of a £36,000,000 expansion plan. These compressors supply air to the body fabrication shops, press shops and other departments, providing power for clutch movements; resetting presses; mechanical handling; loading; welding; and mixing and spraying paint. In addition air is supplied for a number of pneumatic tools such as wrenches, grinders, drills and hoists.

ECONOMIC INSTALLATION

The AR9 compressors were installed at a cost below that estimated for other compressors of the same capacity. The reason being that the AR9 occupies 25% less floor space than is normally required —with consequent economies in compressor house costs.

HIGH OUTPUT

The Atlas Copco AR9 combines thorough reliability of performance with unusually high output per horsepower consumed. The installation at Vauxhall's has a total output of 22,540 c.f.m.

A COMPLETE RANGE OF COMPRESSED AIR EQUIPMENT

Atlas Copco manufactures portable and stationary compressors, rock-drilling equipment, loaders, pneumatic tools and paint-spraying equipment. Sold and serviced by companies or agents in ninety countries throughout the world.

Atlas Copco PUTS COMPRESSED AIR TO WORK FOR THE WORLD

Contact your local company or agent or write to Atlas Copco AB, Stockholm 1, Sweden or Atlas Copco, (Great Britain) Limited, Maylands Avenue, Hemel Hempstead, Herts.

C.16

HOLSET NON-BONDED RUBBER CRANKSHAFT DAMPERS

A combined torsional vibration damper and pulley offers a unit ready balanced and assembled, for immediate fitting to the engine crankshaft.
No other non-bonded damper offers this simplicity and proven reliability.

THIS NEW APPROACH MEANS —

INCREASED RELIABILITY AT REDUCED COST

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ASQUITH

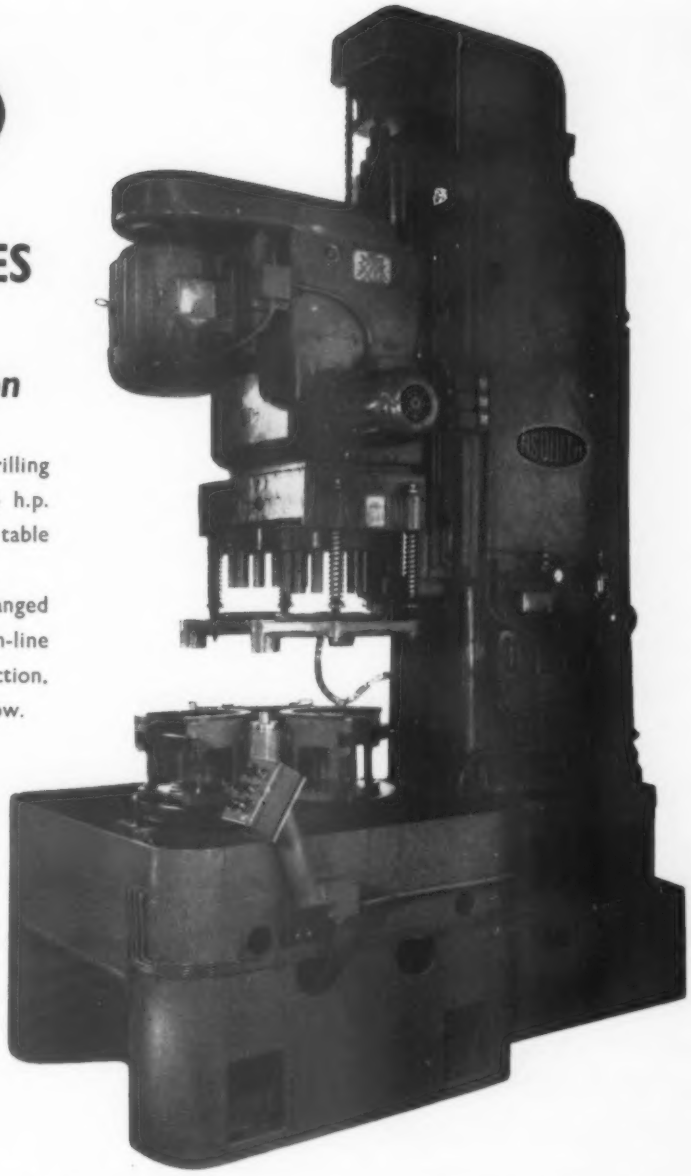
UNIT TYPE MACHINES

fully engineered for high-output production

The example opposite is a 3-station machine for drilling and reaming operations and incorporates a 7½ h.p. screw unit. The 36 in. diameter hand indexing table is provided with air lift and automatic clamping.

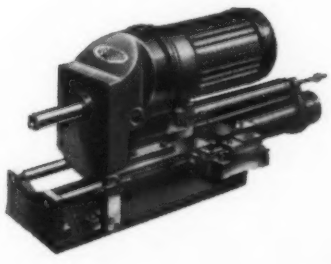
Asquith Units from ½ h.p. upwards can be arranged as individual, multi-way, rotary transfer and in-line transfer machines for fast, automatic production. Some of the unit heads available are shown below.

If you require large-quantity production of components at present produced on several machines, it will be worth investigating the possibility of machining them on an Asquith Unit Type Machine. Write today for details of the range of unit equipment or ask for a specialist to discuss your problem.

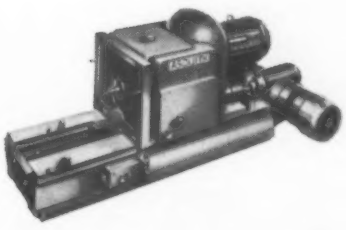


WILLIAM ASQUITH LTD.
HALIFAX · ENGLAND

½ H.P. AIR HYDRAULIC DRILLING UNIT



3/5 H.P. SCREW FEED UNIT



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A302

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Deep in the heart of the richest country of the ancient world, Egypt, was discovered the tomb of Tutankhamun, known in history for the splendour of his burial.

And deep in the heart of the world's finest car engines another treasure is hidden . . . silent . . . enduring . . . vital . . . a Renold Timing chain. It's a gem of a chain—smooth running and flexible, capable of innumerable driving arrangements and outliving the engine itself.

RENOLD **TIMING CHAINS**
stand the test of time

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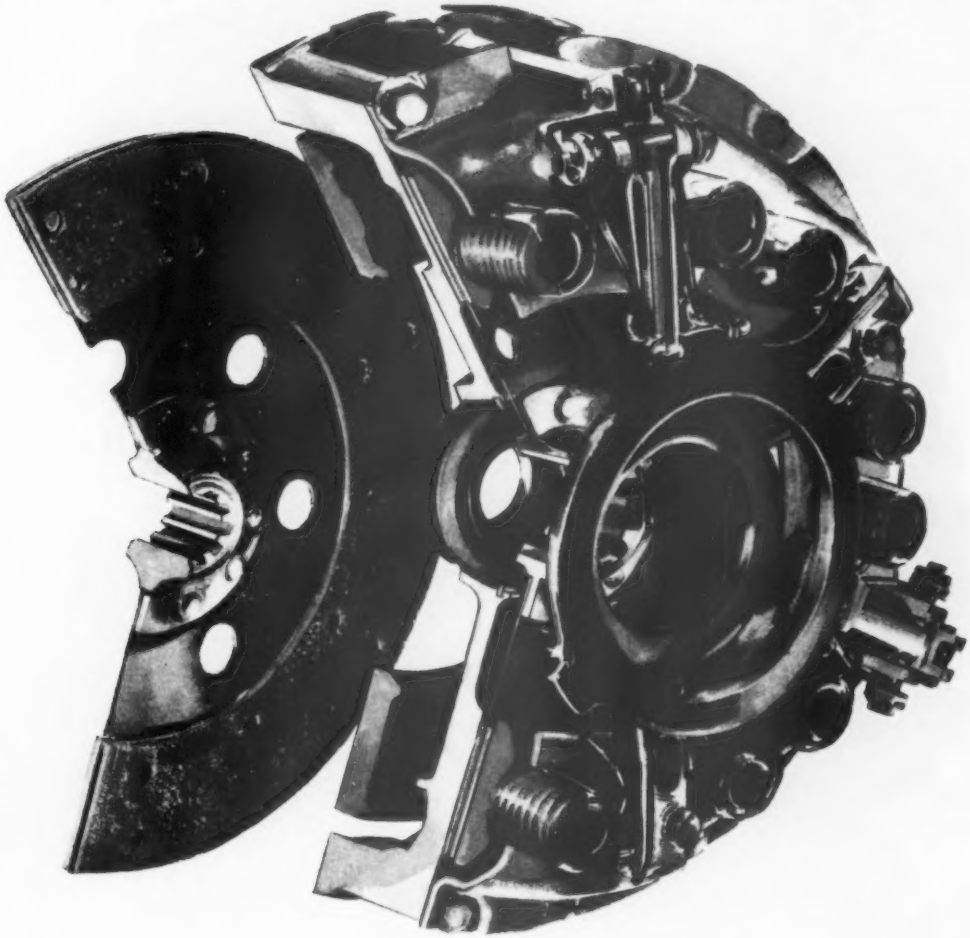
FOR AGRICULTURAL TRACTORS



The integral clutch and power take-off for tractors comprises two clutches mounted in tandem. The clutch nearest the flywheel transmits the drive to the rear wheels through the usual splined clutch shaft; the other clutch provides a power take-off for driving a combine, baler, mower or other machine and transmits its power through a hollow splined shaft.

In most cases a separate engine for driving implements is rendered unnecessary.

The two clutches have independent throw-out forks with ball-thrust bearings.

In addition there is a wide range of Rockford over-centre clutches and power take-offs, and an extensive range of Borg & Beck clutches covering all requirements. Ask our representative to call and discuss your problems.

BORG & BECK

REGD. TRADE MARK

BORG & BECK COMPANY LIMITED

LEAMINGTON SPA, WARWICKSHIRE, ENGLAND

One of the Automotive Products Group

SPECIALIZED COMPONENTS

Only the Purolator system of plastic-impregnated paper filtration will prevent rapid deterioration of tractor engines working under arduous conditions of dust and grit in the field.

AIR FILTERS

The Purolator Micronic filter element, originally developed for lubricating oil filtration, and made by a patented process, is now established as being equally satisfactory for air cleaning. It is capable of arresting particles of foreign matter which are small enough to be measured in microns. These filters are particularly suitable for use on combine harvesters, where engines work under conditions of excessive dust.

PUROLATOR

Regd. Trade Marks: Purolator Micronic

MICRONIC FILTERS

OIL FILTERS

Purolator Micronic full-flow filters are designed to handle all of the oil which goes to the engine bearings under normal operating conditions. A relief valve is incorporated in each filter head to ensure a continuous supply of oil should the element have been allowed to become completely choked through neglect. Designed for mounting directly on to a machined facing on the engine crankcase, these models dispense with external piping.

FUEL FILTERS

These diesel-engine fuel filters are designed to give final protection immediately prior to the injection pump. The filter head is provided with a double bracket for left or right-hand mounting. The body, of drawn steel, has ample capacity for water and sediment, which may be drained off periodically. Our engineers will be pleased to discuss your filtration problems on request.

AUTOMOTIVE PRODUCTS COMPANY LIMITED
LEAMINGTON SPA, WARWICKSHIRE, ENGLAND

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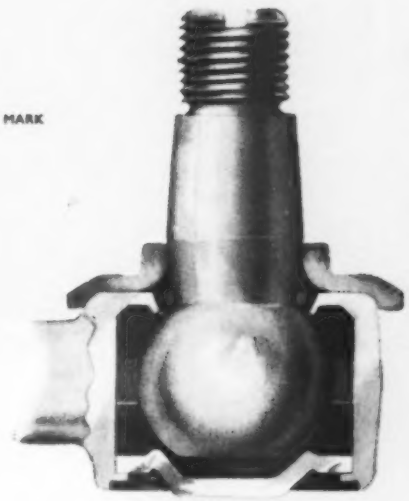
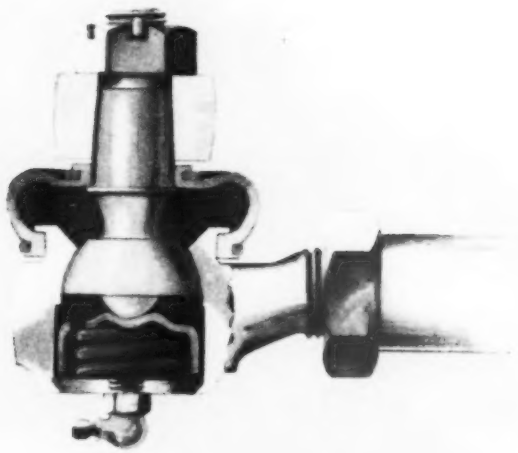
FOR AGRICULTURAL TRACTORS

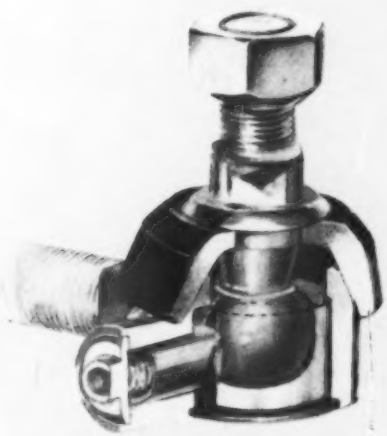
Autolube REGD. TRADE MARK

SELF-LUBRICATING JOINTS

Autolube joints give 'built-in' automatic lubrication, eliminating servicing at inaccessible points. Two resilient fabric bushings, impregnated with a patented 'dry' lubricant, carry the normal steering loads, and provide freedom from backlash. Between the resilient bushings is a Nylon ring which protects the fabric from shock and overloads, and enables it to retain the lubricant, which is essential to the prolonged life of the joint.







The daily operation of tractors over the roughest of ground and under the most arduous conditions calls for steering rod assemblies which will withstand continual hard wear without the need for constant maintenance and adjustment.

Thompson steering joints have been specially designed to meet these requirements. The automatic adjustment takes up wear and ensures tight connections without any assistance from the operator and particular attention has been paid to the exclusion of dust and dirt.

Finally, meticulous accuracy in the manufacture of these joints, by the most modern methods, gives a certainty of complete reliability.

Thompson

SELF-ADJUSTING BALL-JOINTS

AUTOMOTIVE PRODUCTS COMPANY LIMITED
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Lockheed

REGD. TRADE MARK

MECHANICAL BRAKES

FOR TRACTORS & TRAILERS

For general use as primary brakes and steering brakes for equipment such as farm tractors, farm machinery, farm and industrial trailers, etc., etc.

They form a light, powerful, inexpensive braking system giving controlled safety with maximum economy and negligible maintenance. For actuation manually, or remotely by vacuum and air systems.

Leading and trailing shoe brakes of the centre-pull type, are available in a range of sizes, for 7″ drum, shoe width 1¼″, 8″ (1½″), 9″ (1¾″ and 2¼″), 10″ (1¾″). The 9″ x 2¼″ brake has a lever for rod or cable operation, to pull across the backplate.

LOCKHEED HYDRAULIC
BRAKE COMPANY LIMITED
LEAMINGTON SPA, WARWICKSHIRE

Lockheed *Avery*

FLEXIBLE HOSE AND SELF-SEALING COUPLING

The 'Hydralinc' coupling shown enables the user to make the most of his hydraulic implements. Hydraulic lines can be quickly connected and disconnected without loss of fluid or inclusion of air.

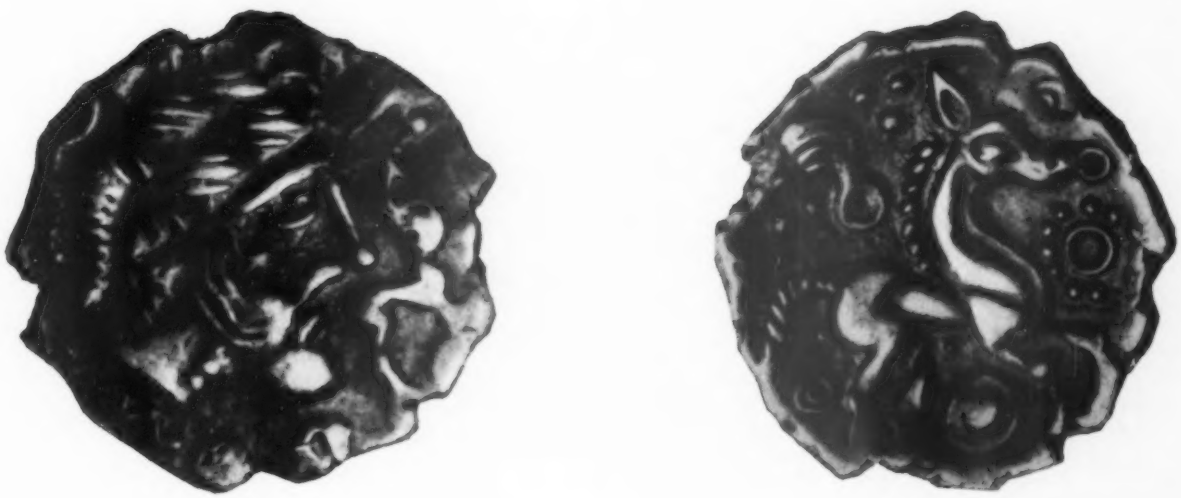
There is no need to prime fluid systems fitted with this coupling. For pressures up to 3,000 p.s.i.

Lockheed-Avery hoses are made to a very high specification in order to provide consistent durability in agricultural usage. The end-fittings are re-usable when the hose is renewed.

LOCKHEED PRECISION PRODUCTS COMPANY LTD.
SHAW ROAD, SPEKE, LIVERPOOL, 24.

One of the Automotive Products Group

Rare coin believed to have been struck 20 B.C. by the ancient British tribe of the Catuvellauni. Uninscribed it is probably one of the prototype coins struck after the Whaddon Chase gold coins and before the inscribed coins of Tasciovanus, King of the Catuvellauni and father of Cunobeline, or Cymbeline, of Shakespeare's play.



When this coin recently bobbed up through the Hertfordshire subsoil, even the most learned antiquaries didn't seem to have much of a clue what it was all about. But isn't it obvious! says the M.D. Observe the obverse side, he says . . . the character in that face . . . that excellent *moustache.* Observe the reverse side, he says . . . that horse. . . that willing *little horse.* Even then our forward-looking ancestor must have been messing about with the idea. All he needed were some descendants and 1900 years' progress to get the thing properly organised. It all goes to prove, says the M.D. proudly . . . moustaches are born, not made.

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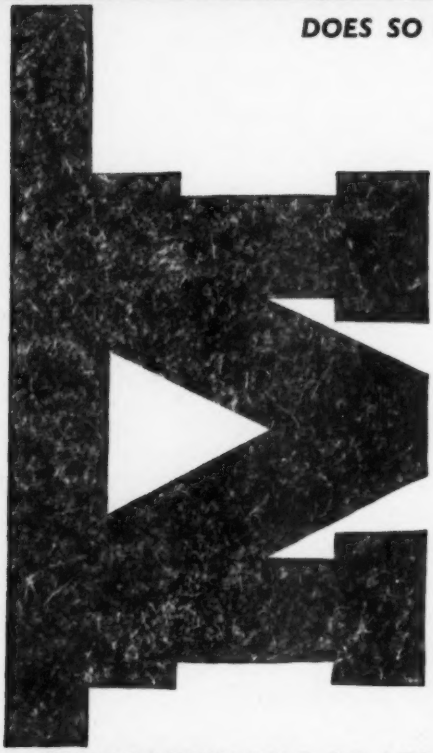
MEADOWFELT

DOES SO MANY JOBS SO WELL . . .



Meadowfelt—satin-soft or rock-hard—is available in piece-goods and also in washers, gaskets, strips, anti-vibration pads and all cut parts—made to *your* specification.

Are *you* making full use of Meadowfelt? It could almost certainly effect economies and solve many of your production problems. A discussion would take up little of your time—why not arrange for a representative to call?

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(A.I.D., A.R.B. and I.A. approved)

TRANSMISSION NOISE

How Metalastik tackle and solve the problems

Many transmission systems which, from their design and workmanship, could be expected to be reasonably quiet, do in fact turn out to be unexpectedly noisy.

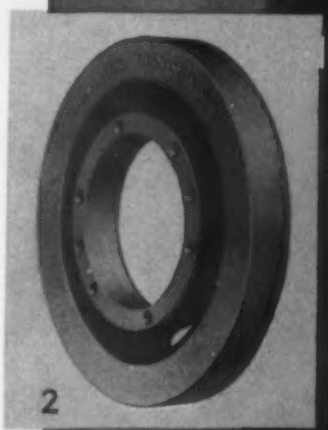
We have analysed and diagnosed a number of such cases, and find that as a rule resonant torsional vibration is the culprit, a conclusion which agrees with the practical observation by some engineers that a normally noisy transmission becomes markedly quieter when driven through a fluid flywheel.

In most cases, one or another form of the Metalastik torsional vibration damper makes a striking improvement. Two forms, shown at 1 and 2, are used when analysis has shown the trouble to be due to resonant torsional vibration or cyclic fluctuation of the flywheel. They can be fitted in either of the positions shown, either behind the gearbox or in front of the final drive. When the amplitudes are unusually large the Metalastik unit No. 3 is used.

This is not an inertia-type damper but a flexible coupling, in which low torques—at which most of the flutter occurs—are transmitted with considerable flexibility by a bush in torsion, the buffers taking up the drive only at high torque. This coupling is fitted between engine and gearbox.

Our engineers are always available to investigate problems and to bring to bear their unsurpassed experience.


1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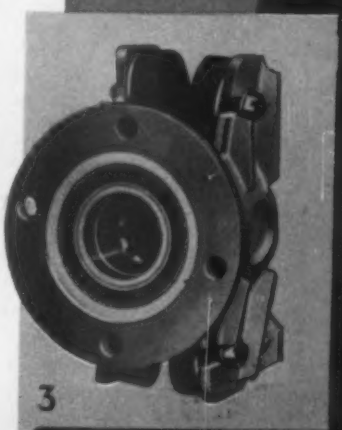
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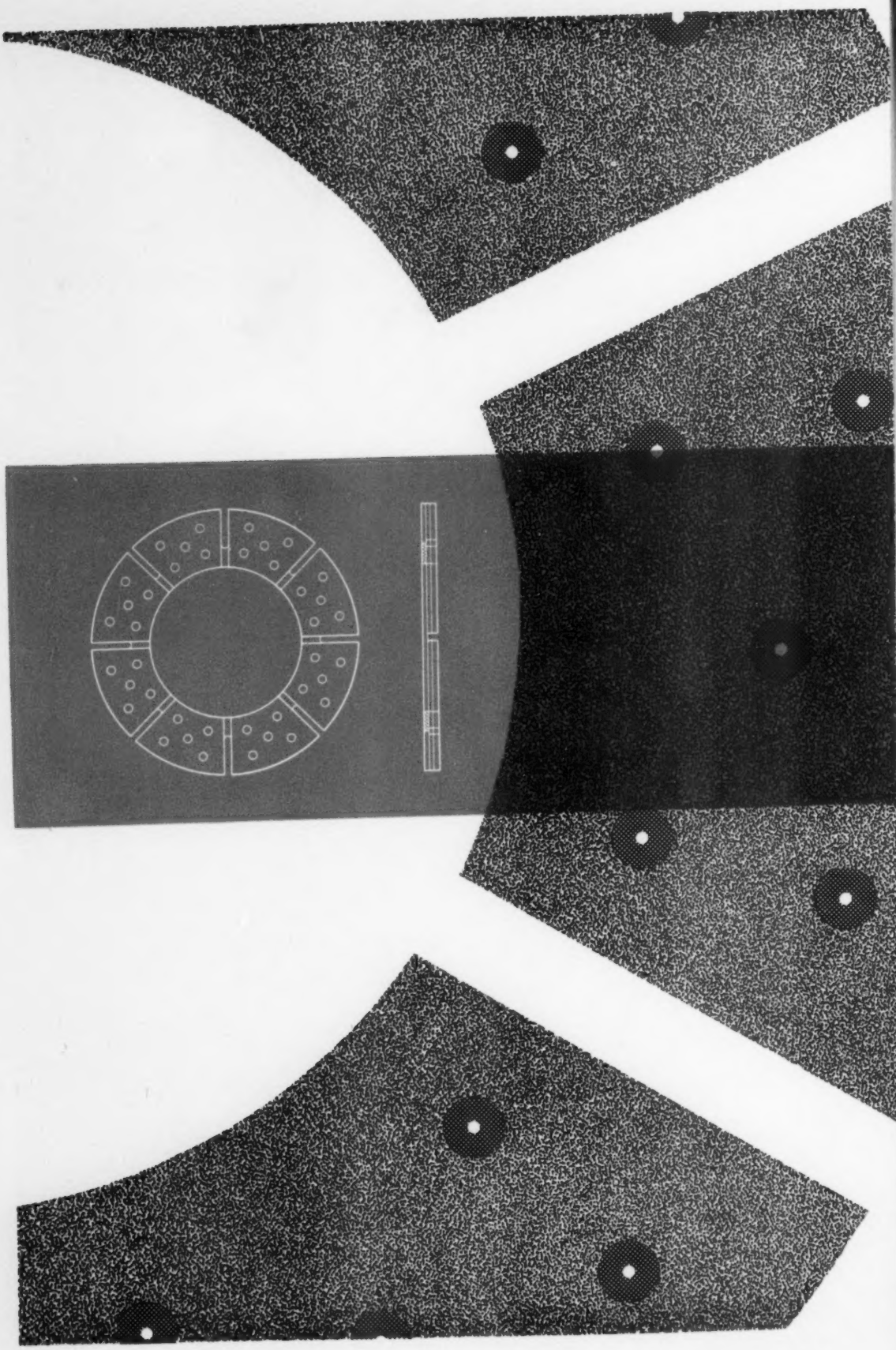
METALASTIK



LEY'S

LEMAX

PEARLITIC

MALLEABLE

CASTINGS

Flame-hardened internal gear

This 'Lemax' casting, for a commercial vehicle planetary two-speed axle, combines the hardened internal gear with part of the differential housing.

The casting, which is 11 inches diameter and weighs 38 lb., meets the following specification:

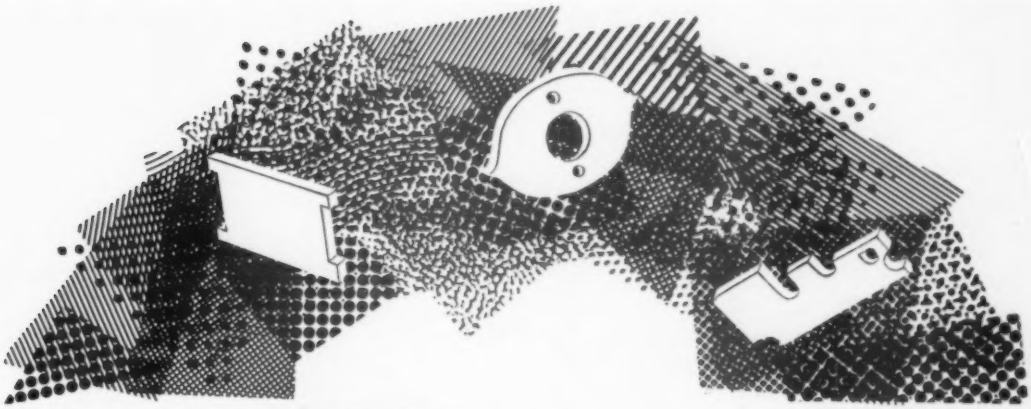
Gear-teeth: **flame-hardened.**
Journal: **induction hardened.**
Min. tensile strength: **100,000 P.S.I.**
Min. yield strength: **80,000 P.S.I.**
Min. elongation in 2" : **2%.**

Registered Trade Marks: 'Black Heart' 'Ley's' 'Lepax' 'Lemax'

LEY'S MALLEABLE CASTINGS COMPANY LIMITED

DERBY, ENGLAND. ***Telephone:*** **Derby 45671**

LEY'S



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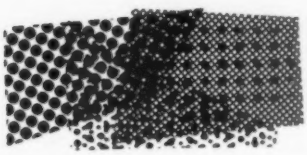

You'll find Bury Felt everywhere—as washers, seals and gaskets, polishing bobs, anti-vibration bases and buffing rollers. These are only a few of its hundred and one uses. You will think of many more. For Bury Felt is what you make of it; it can be chiselled, punched, machined or die-cut to suit your needs and is available in many types and textures.

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LEY'S 'LEMAX' PEARLITIC MALLEABLE CASTINGS

Flame-hardened internal gear

This 'Lemax' casting, for a commercial vehicle planetary two-speed axle, combines the hardened internal gear with part of the differential housing.

The casting, which is 11 inches diameter and weighs 38 lb., meets the following specification:

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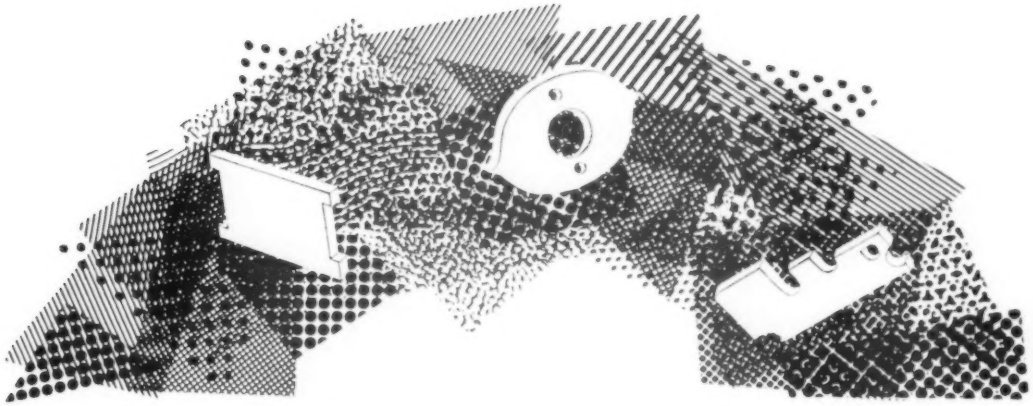
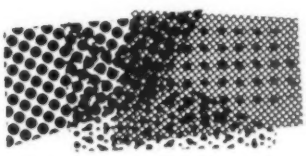
Journal: induction hardened.
Min. tensile strength: 100,000 P.S.I.
Min. yield strength: 80,000 P.S.I.
Min. elongation in 2" : 2%.

LEY'S MALLEABLE CASTINGS COMPANY LIMITED
DERBY, ENGLAND. *Telephone:* Derby 45671

LEY'S



Let BURY FELT solve your problem



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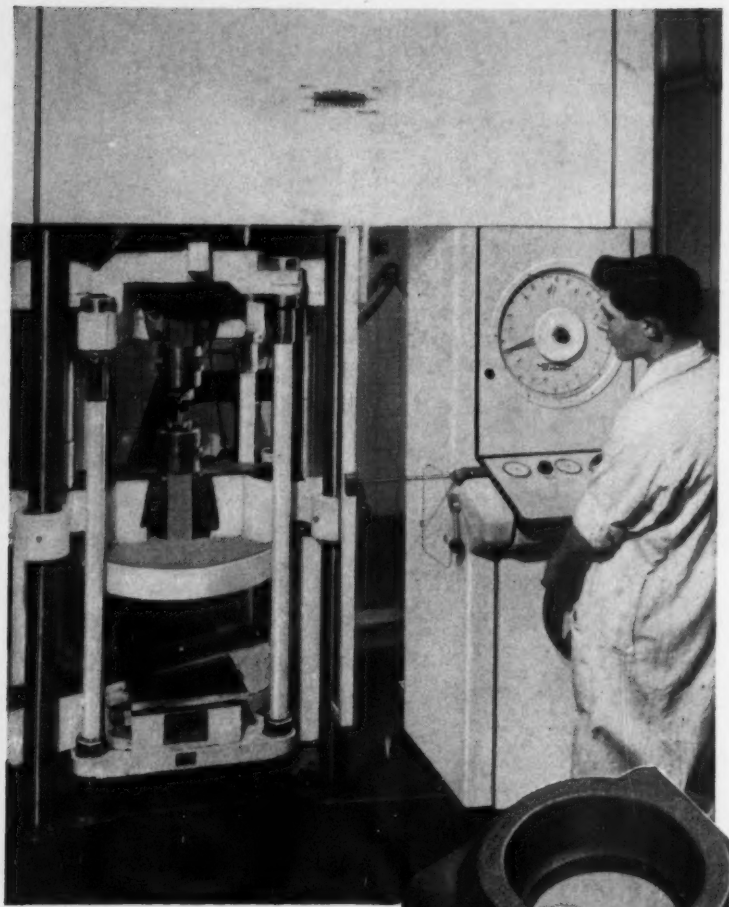

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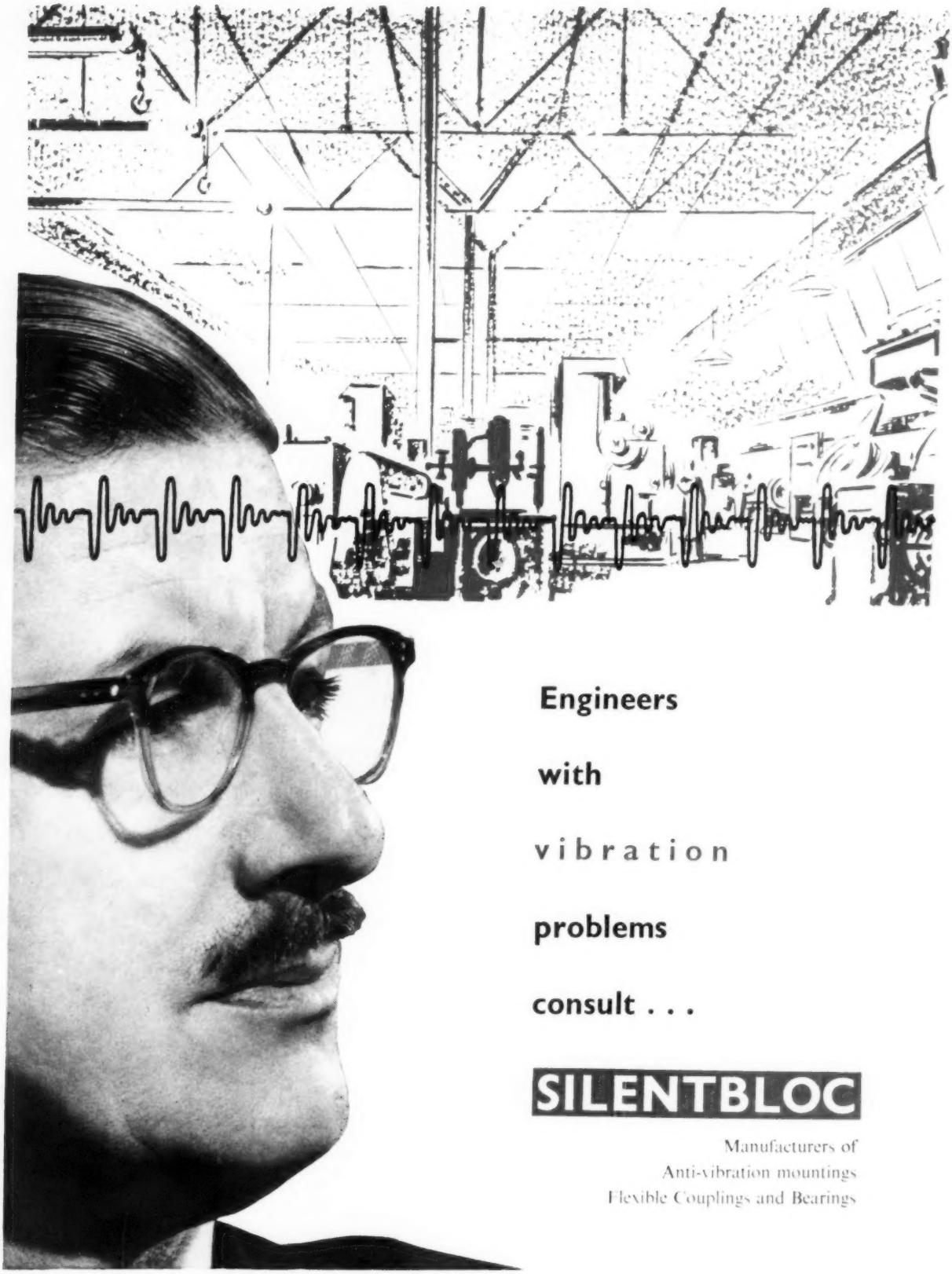

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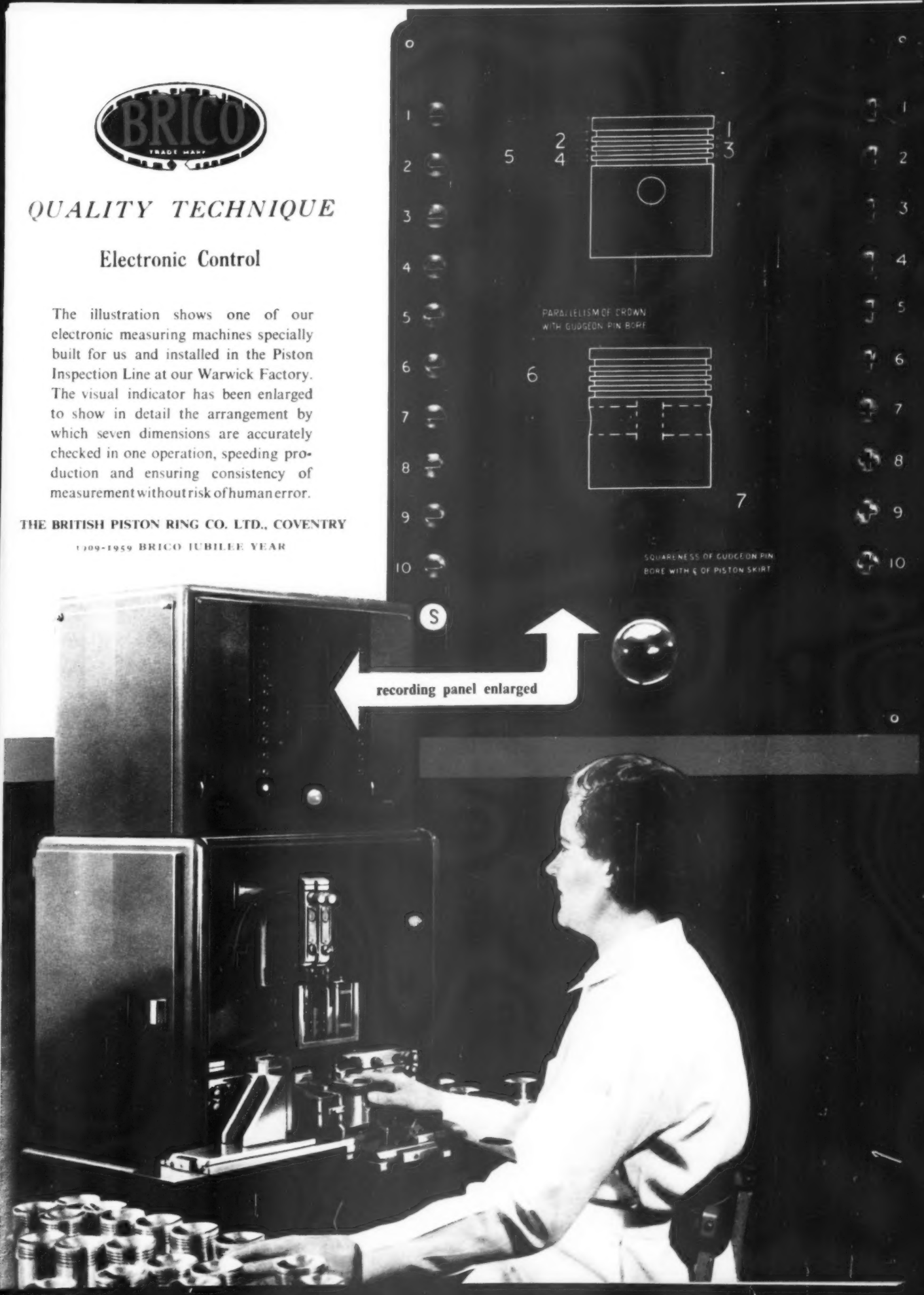
Electronic Control

The illustration shows one of our electronic measuring machines specially built for us and installed in the Piston Inspection Line at our Warwick Factory. The visual indicator has been enlarged to show in detail the arrangement by which seven dimensions are accurately checked in one operation, speeding production and ensuring consistency of measurement without risk of human error.

THE BRITISH PISTON RING CO. LTD., COVENTRY

1909-1959 BRICO JUBILEE YEAR



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CUMMINS	VICKERS-ARMSTRONG
DAVEY, PAXMAN	VOLVO
GARDNER	etc. etc.

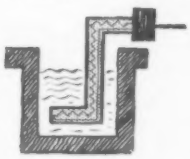
FARNBOROUGH ENGINEERING CO. LTD · FARNBOROUGH · KENT

Resistance Heating – 2

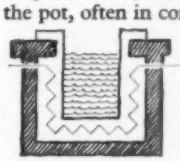
Electric resistance heating elements have been briefly described in Data Sheet No. 4, with two examples of their application in industry. This sheet lists some of the further applications which can be effectively dealt with by resistance heating.

Soft Metal Melting

Electric resistance melting is most commonly used for lead, tin, zinc, antimony, aluminium and their alloys—in processes such as tinning, type-casting, die-casting and lining bearings—at temperatures of up to around 800°C.



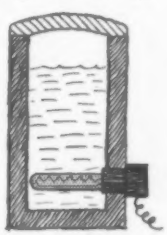
In most cases, sheathed elements are immersed directly in the metal, a more efficient method than applying heat to the outside of the containing vessel or pot. Immersion heating simplifies the application of lagging to the outside of the vessel, reducing heat losses and current consumption to a minimum. The elements are usually positioned near the inside wall of the vessel, leaving plenty of working space, but in a few cases, where the full volume of the pot is required, or where the metal to be melted is particularly corrosive, the elements are positioned outside the pot, often in contact with it.



In all cases, the precise temperature control that is so essential in soft metal processes is readily achieved by the use of electricity, and electric heating also leads to a reduction of casting rejects and metal wastage and a marked improvement in working conditions.

Liquid Heating

Electricity provides the ideal way of heating liquids such as water, oils, varnishes, plating, photographic and other solutions, and of melting and heating waxes and compounds, glues and pastes, tars and bitumen. Again, immersion heating is the method most commonly employed, but considerations of space or the nature of the liquid may sometimes necessitate the use of external heaters. Several types of devices are available to give precise and automatic temperature control, and lagging is again commonly applied to the vessel to minimise heat losses.

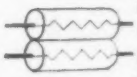


Fire hazards associated with inflammable liquids are invariably reduced by electric heating, particularly if immersion heaters can be used.

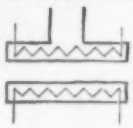
It is usually possible without difficulty to apply electric heaters, either immersion or external, to existing vessels.

Platen, Press and Roll Heating

Electricity offers the simplest and most convenient method of heating platens, dies and rolls. It gives the precise temperature-control characteristic of electric heating systems, with lower maintenance costs. Moreover, the relatively high temperatures required in some processes for maximum working speeds are reached without difficulty. Flexible electrical connections to moving parts give far less trouble than flexible pipe connections carrying hot water or steam.

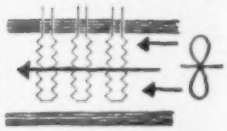


When electric heating is used, one or more presses can be operated without the necessity of keeping a boilerhouse staff at work.



Air Heating

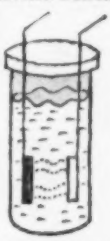
Streams of air, and of many other gases, can be heated most efficiently by electric resistance elements disposed across the duct leading to or from a fan. Heat is generated only inside the duct, just where it is required, and none is carried away through exhaust flues or pipes. Quick rise of temperature and precise temperature control are assured when electric resistance air heaters are used.



Electric Steam Boilers and Steam Raising

When steam is essential to a process, electrical steam raising can often be fully justified on economic grounds.

The means employed for bringing steam from a boilerhouse to the point of usage are often extremely wasteful, but where electricity is used the steam can be generated on the spot and losses from steam mains are eliminated. The efficiency of the electric boiler normally exceeds 96% and is practically constant at all loads, while the rapidity with which steam can be raised very largely eliminates banking losses.



Plant requiring process steam can be equipped with its own electric steam boiler, freeing the working space of steam mains just as individual electric motor drives free the factory of masses of shafting and belt drives.

Even where boilerhouse steam is still used, it is sometimes desirable for best results to boost the steam temperatures at the point of usage, to make up for transmission heat losses or to increase the superheat, and this function can most conveniently be performed by an electric resistance heater inserted in the steam line.

For further information get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, W.C.2. Telephone: TEMple Bar 9434.

Excellent reference books on electricity and productivity (8/6 each, or 9/- post free) are available – "Resistance Heating" is an example; "Induction and Dielectric Heating" is another.

E.D.A. also have available on free loan a series of films on the industrial use of electricity. Ask for a catalogue.

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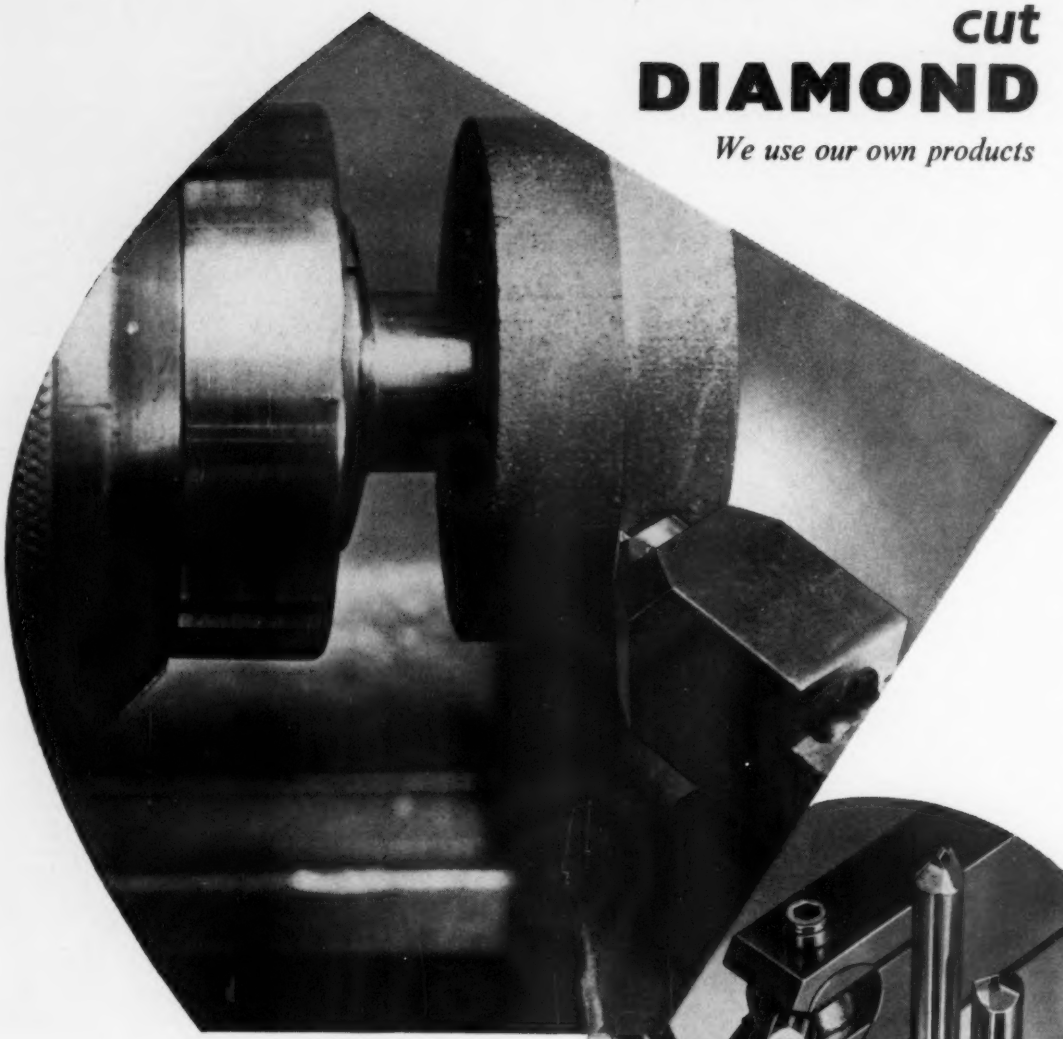

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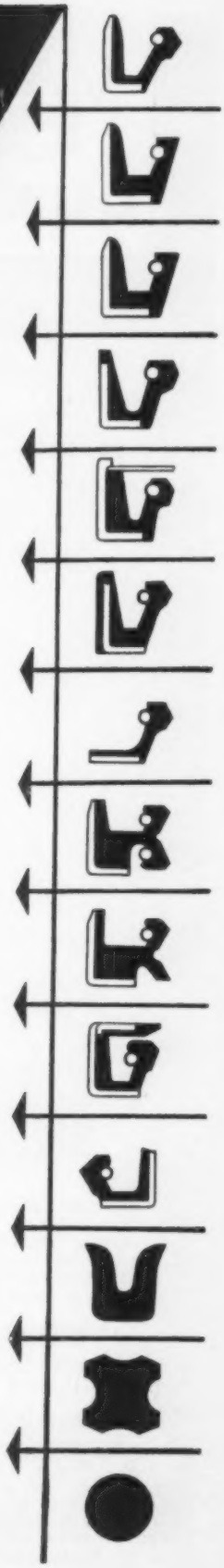

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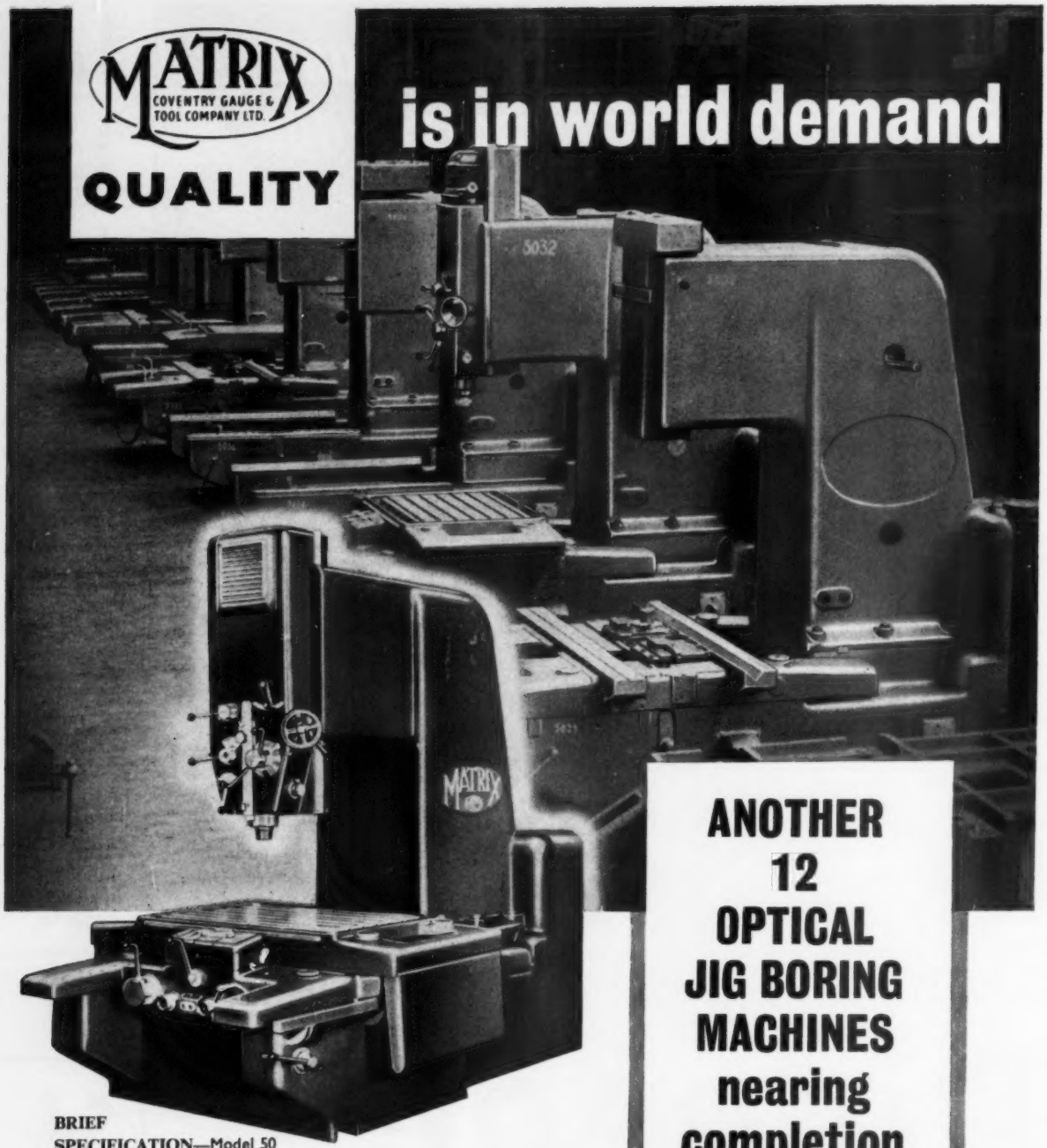

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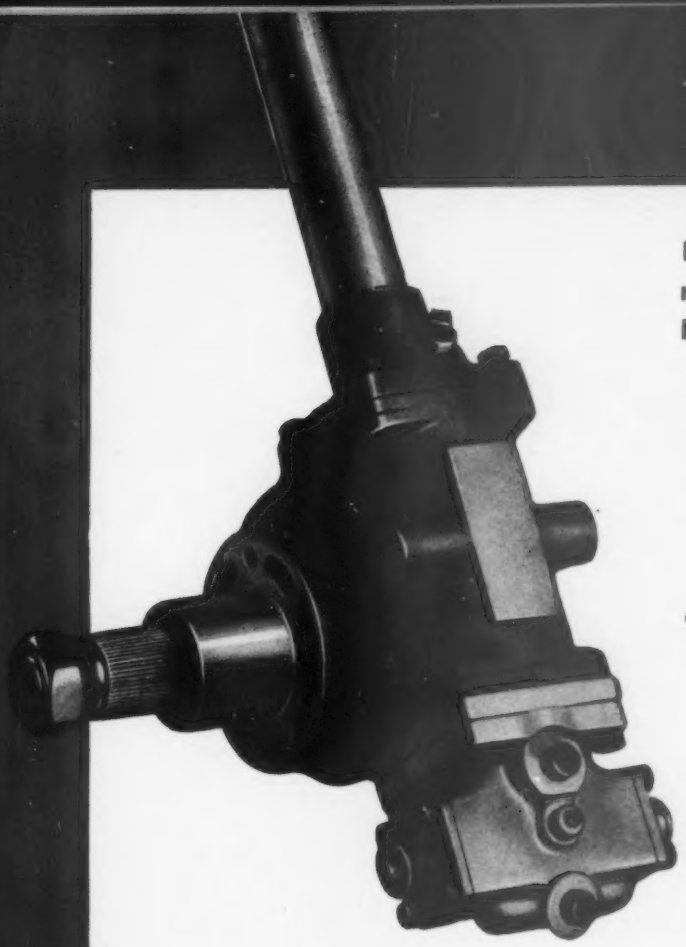

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Illustrated above is the Type 3 'Universal' steering gear which incorporates the hydraulic control valves mounted upon our type '861' manual gear. This is for use with a separate power pump and with power cylinders operating on the steering linkage. Further particulars will be sent on request.

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Where even the smallest foreign particle may imperil life, nothing is left to chance. Complex units, such as engine oil coolers which cannot be dismantled for inspection, are therefore radiographically examined to detect accumulations of sludge, metal debris, and carbon particles which would spell danger if they circulated in the engine lubrication system.

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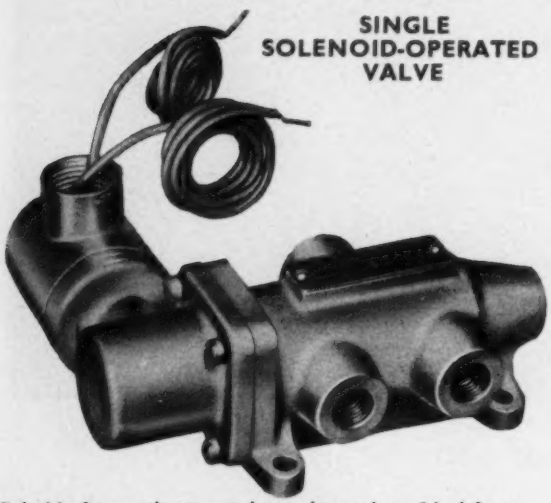
ILFORD

For speedy actuation of air control circuits

Where pneumatic systems require a faster than normal action of reciprocating movements, Schrader's solenoid valves, using electrical limit switches, are the ideal means of actuation. They are of single and double solenoid types. The single solenoid valve operates a balanced poppet plunger only while the solenoid is energized. The double solenoid valve has two electrical circuits and operates or returns in response to momentary energizing of one or other of the solenoids.

SINGLE SOLENOID-OPERATED VALVE



Suitable for continuous or intermittent duty. Ideal for controlling double-acting cylinders at line pressures from 20-125 lb. p.s.i. Air is used to move the valve mechanism in each direction, eliminating the usual return spring.

DOUBLE SOLENOID-OPERATED VALVE

For controlling double-acting air cylinders. Permits a longer dwell time in either direction without the need for continuous electrical energy. Valve mechanism moved from one position to the other with fast, positive action. Pressure range 20-125 lb. p.s.i.

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Please send details of Schrader Solenoid-Operated Valves

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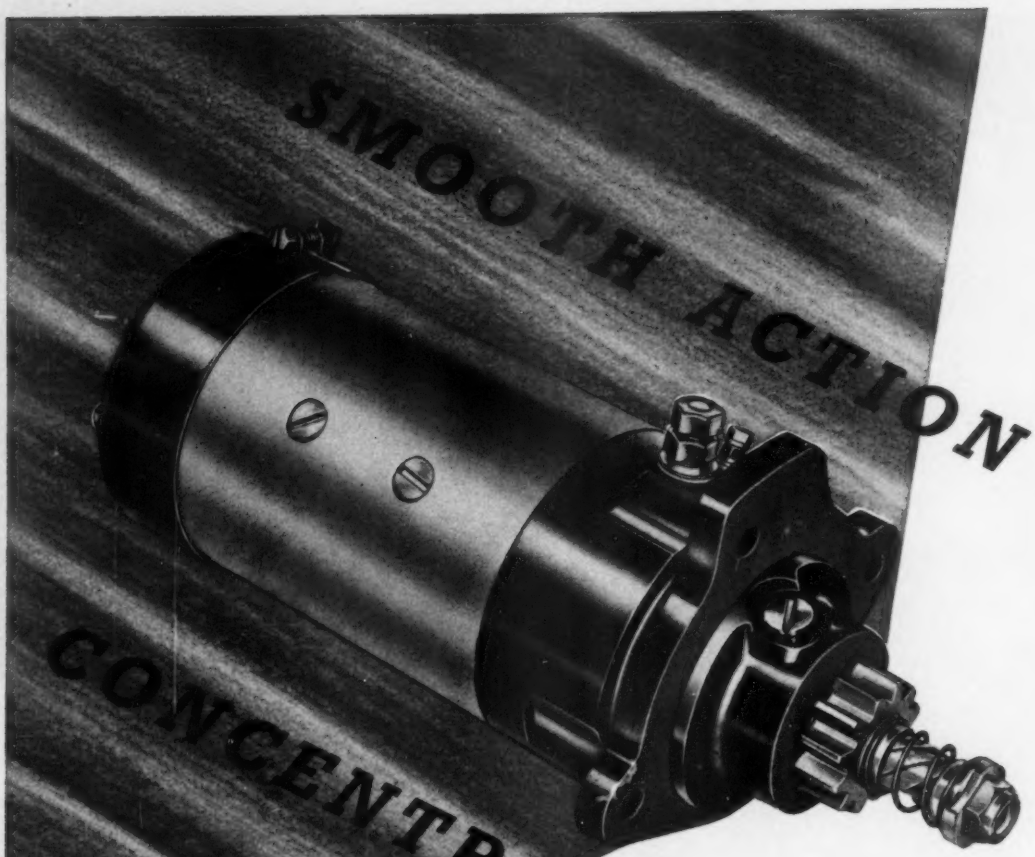

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Lock prevents premature disengagement

Compact for snug installation

Maximum power from minimum size

Robust construction for long life

In the CA45 starter a great deal of power is packed into a small unit. Although only 4½ inches in diameter, the CA45 is suitable for heavy duty and will crank multi-cylinder diesel engines of up to 5 litres capacity. The pinion on its sleeve alone moves axially, operating a trip mechanism which ensures that full torque is applied only when the pinion is in proper engagement. A locking device prevents premature disengagement of the pinion while the starter switch is depressed. Results of exhaustive tests, both in the laboratory and in the field, show that the CA45 is efficient, reliable, and has an exceptionally long life between overhauls.

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- ✱ S-type constant lift cam. Splined to accommodate standard slack-adjusters.
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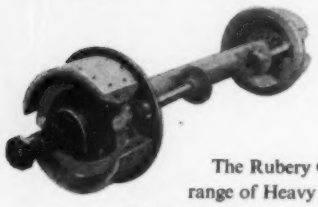
- ✱ Available for either bolting or welding to axle beam.



The Rubery Owen range of Heavy Duty Trailer Axles uses the S-Cam brake as standard equipment.

AVAILABLE SIZES
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16½" × 6" or 7"

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S-CAM BRAKE

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"Assure me, dearest Matilda, it was all an evil dream"

"Oh villainy most vile!" With this wild eldritch cry Egbert started from his pillows. Matilda, hurrying to his side, pleaded with him to disclose the cause of such piteous perturbation.

At length, with many a sigh and groan, Egbert gasped, "Driving upon a dark and lonely road, I was of a sudden set upon by footpads and thieves who seized me, hurled me viciously into the roadway and drove off with joyous laughter, mindless of my plight. Even now those dastardly wights are reaping the fruits of my labours, enjoying my engine's surging power as it makes mock of the direst hill, burning away my precious fluid!" *Overcome with anguish, he could say no more. "Courage, my brave Egbert!" Matilda resolutely entreated him. "You are here, in your own bed, Egbert. You have but dreamt this calamity."

Hope battled with despair in Egbert's face. Clutching her hand in his troubled grasp, he breathed, "Assure me yet again, dearest Matilda, assure me it was all an evil dream."

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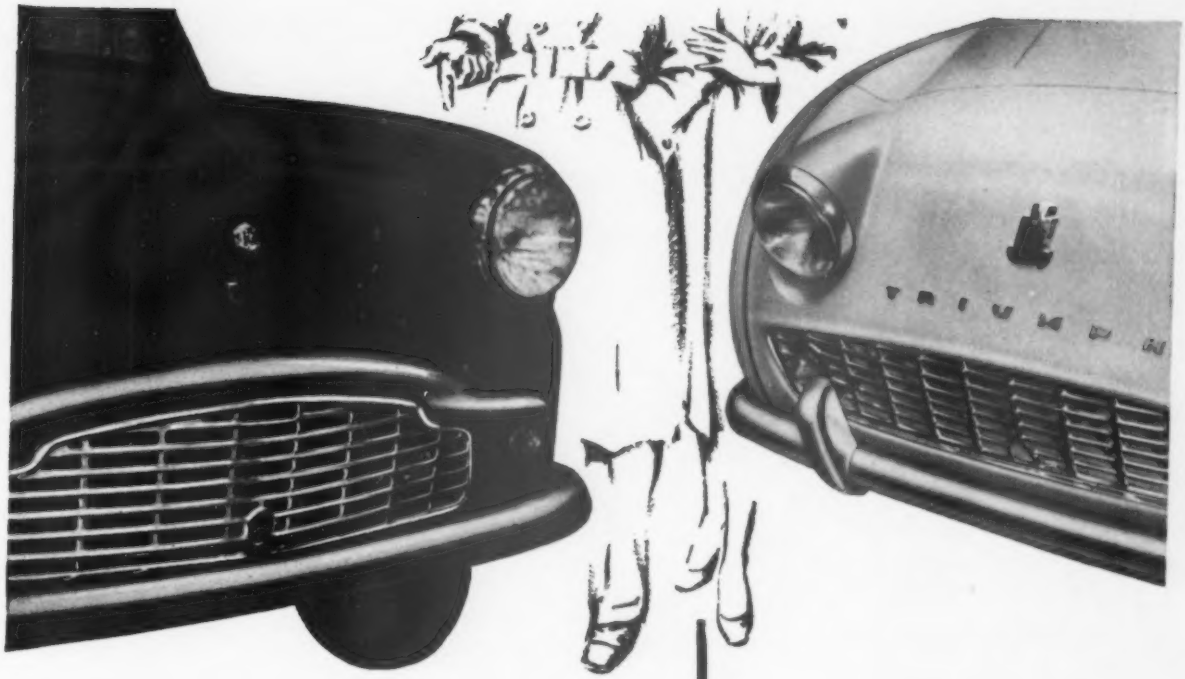

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All current models of the Triumph TR.3, Standard Pennant, Standard Ensign and Standard Ten are being fitted with Birmabright aluminium alloy radiator grilles, as a result of the outstanding success of the trials started over five years ago when Birmabright grilles were put into service on the Triumph TR.2. Chemically brightened and anodised by Charles & Watkins Ltd., these grilles are as attractive to look at as they are durable and trouble-free in use.

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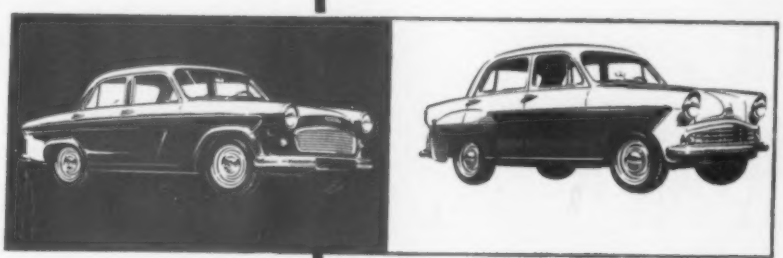

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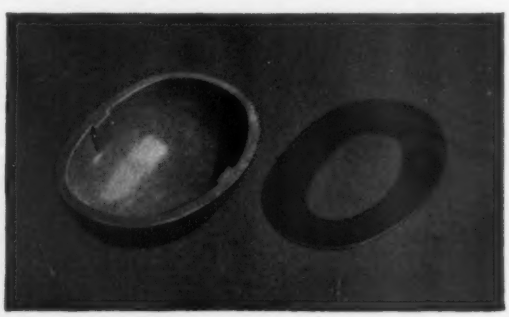
Here's a typical example of how the mechanical strength of Beetle D.M.C. (Dough Moulding Compound) helps to solve industrial problems.

These ear defenders are used to protect the hearing of workers in proximity to jet engines and in noisy factories. During the development work by the makers, Dennis Ferranti Meters Ltd., twelve sets moulded from conventional materials were delivered to Bomber Command for testing. The report of The Central Medical Establishment, Acoustics Laboratory, was that the ear defenders gave excellent protection, but that the mouldings then used were considered too fragile.

D.M.C. mouldings were substituted and have been found virtually indestructible.

D.M.C. is the ideal material whenever high mechanical and/or electrical strength is required. The material can be moulded in conventional compression presses on short cure times and at low pressure. We shall be glad to send full technical details.



This illustration shows the main moulding from Beetle D.M.C. and a retaining piece made from Scarab material. The Earguards are used in engine testing, rivetting, blasting, rolling mills, weaving sheds, paper mills and on aerodromes.

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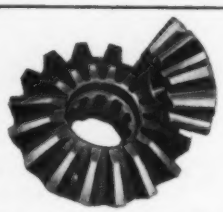

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SALISBURY make most kinds of gears, axle shafts and transmissions for industry and commerce. And Salisbury technicians are always glad to co-operate on new projects and problems. Perhaps they can help you too? Please write for further details.

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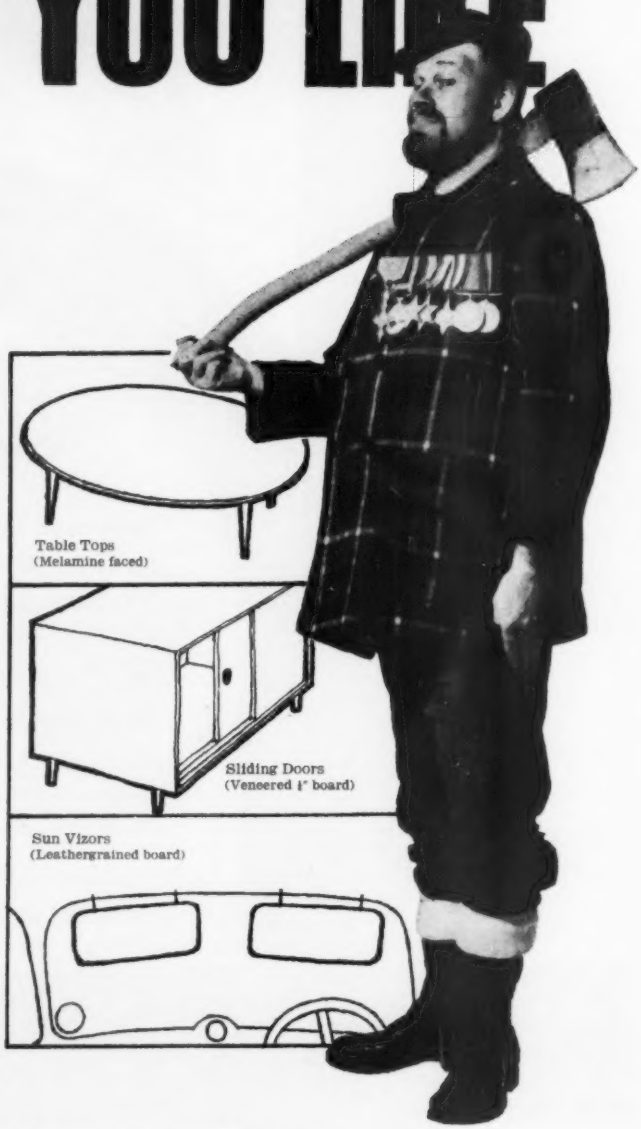

We can give it a P.V.C. skin, a dark stain, or a nice reeded or leathergrained texture. If you prefer to get it decorated yourself, we can put you in touch with the right people for stove-enamel, plastic laminates (such as Melamine), wood veneer, or even flocking. Once one of these decorative finishes is applied, you'll find it hard to believe it's the same material! Small wonder that Bowater Board is replacing traditional materials in so many products like these three shown here, for example.

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CRC 62B1

For the new Triumph car, as for most new vehicles, pilot runs of several different large pressings for pre-production prototypes were urgently needed before the production line was fully established.

Western were called in to produce pre-production batches of certain body panel pressings. Standard were delighted with the results.

The Western soft tool method of producing pressings is especially suited to the manufacture of panels and body pressings where the quantity involved does not justify the high cost of producing steel tools; or alternatively where vehicle manufacturers speedily require pre-production runs of pressings in advance of completing tools for main production.

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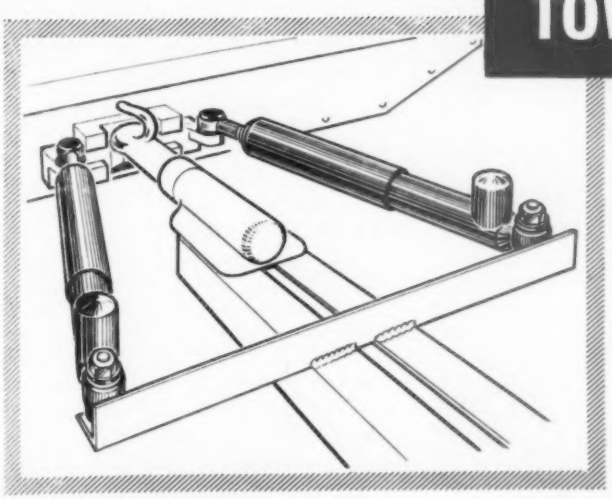

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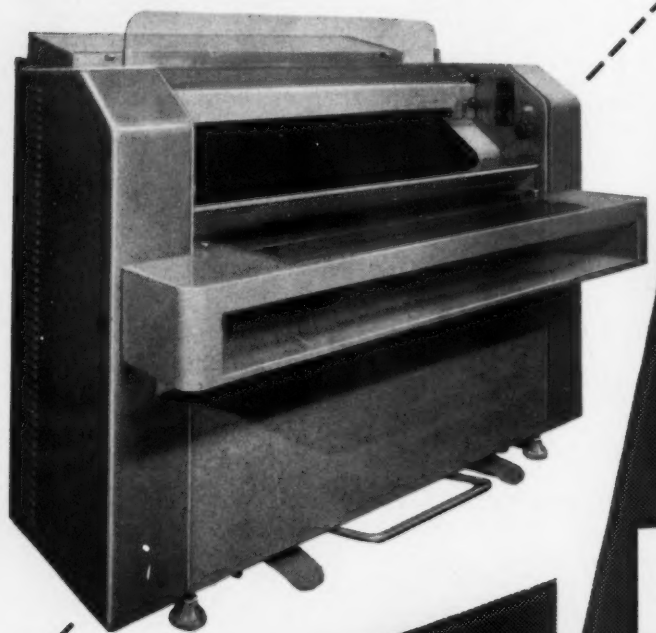

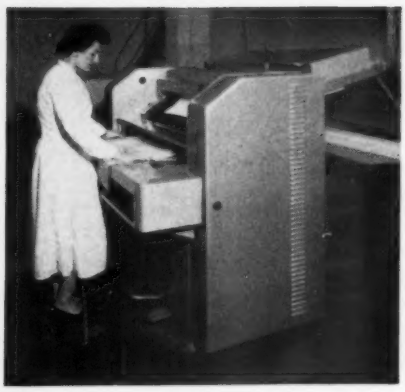

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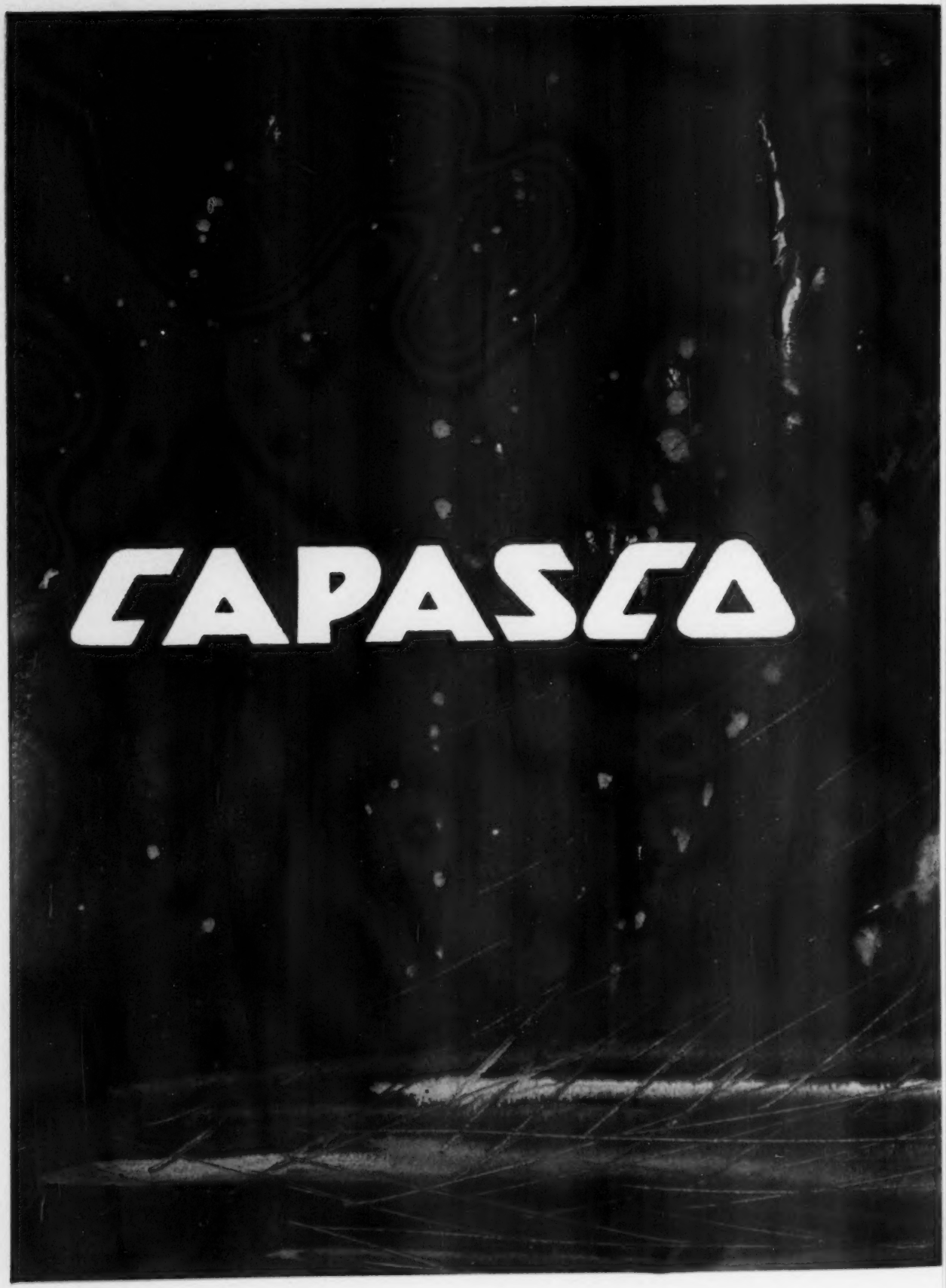
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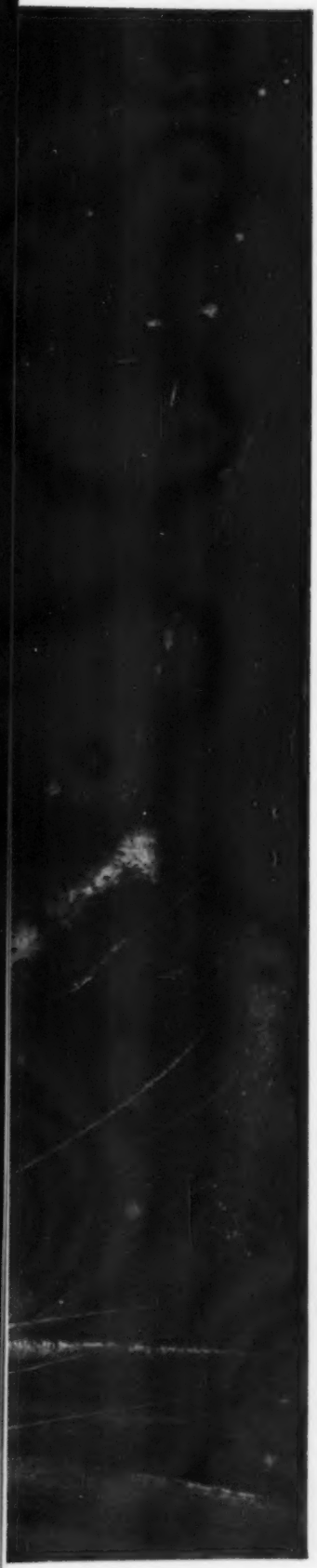

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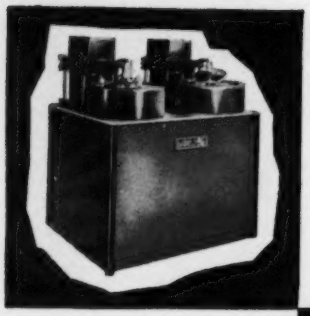

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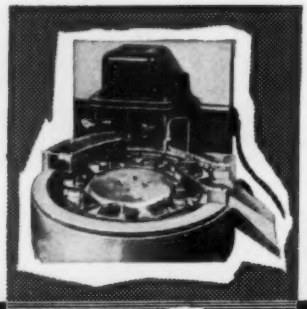

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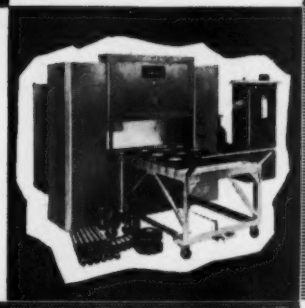

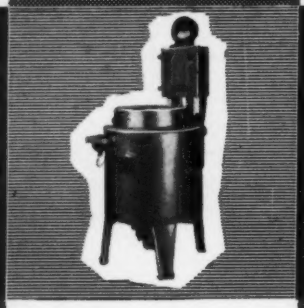

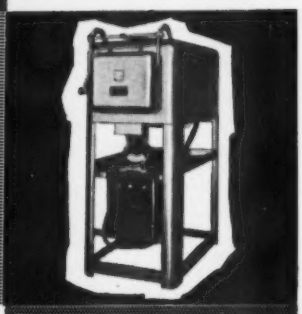

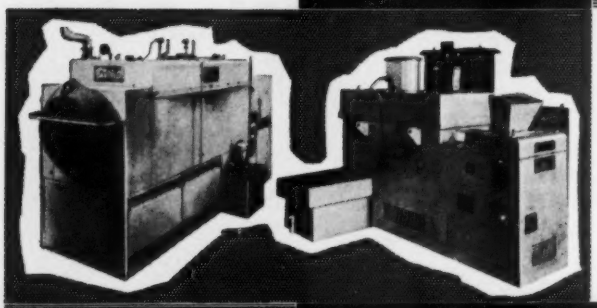

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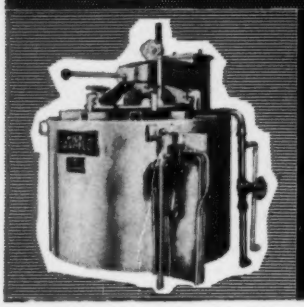

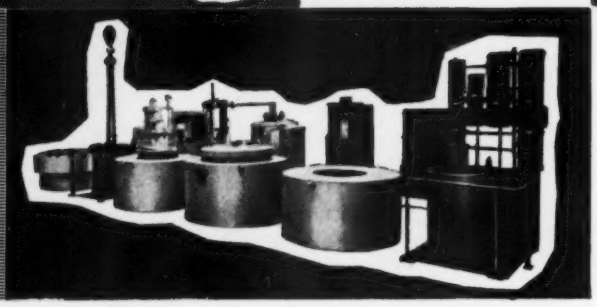

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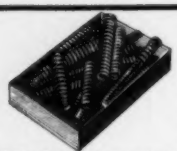

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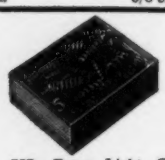

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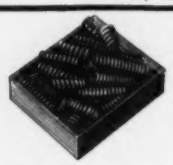

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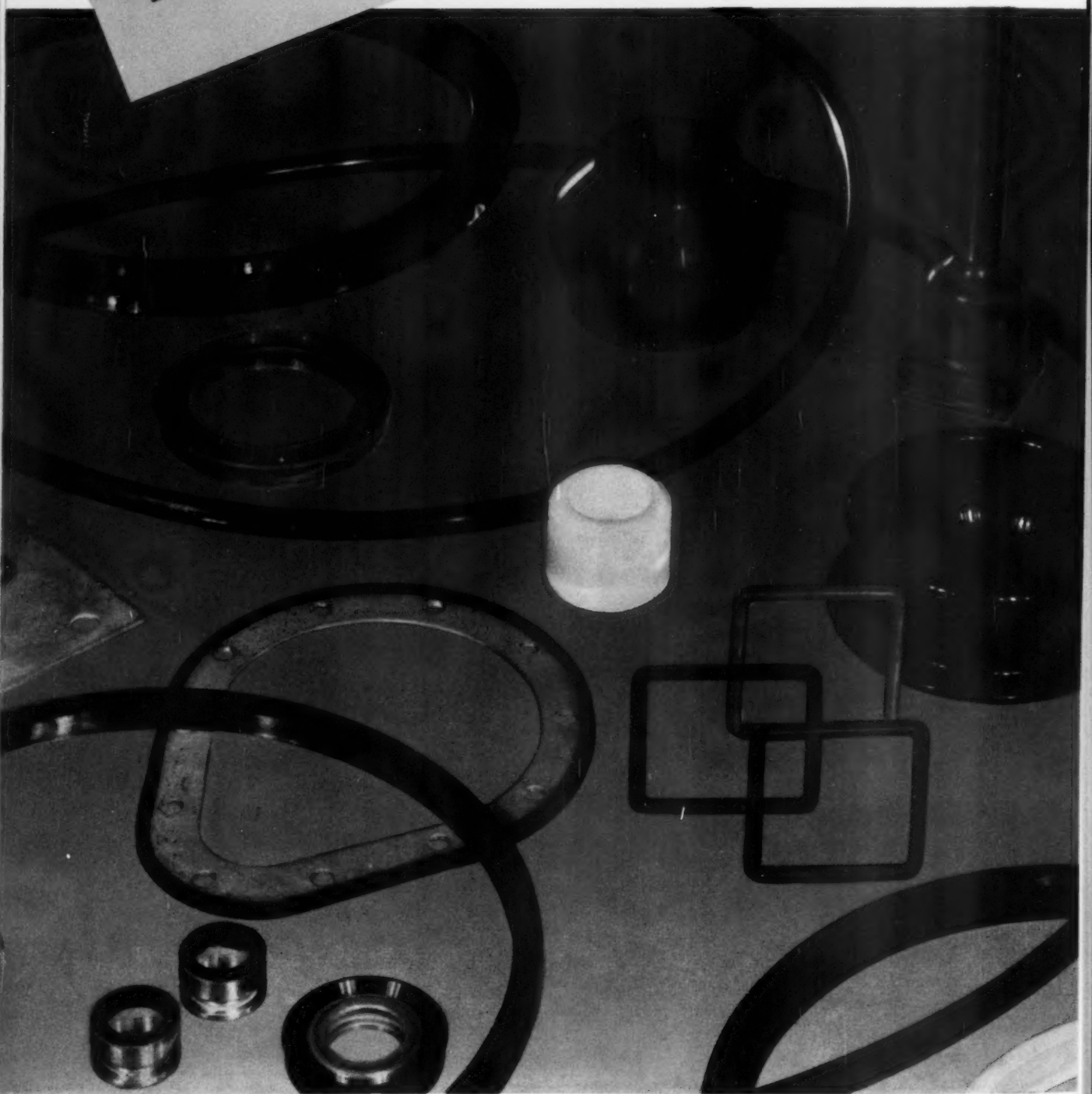

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AUTOMOBILE ENGINEER

CONTENTS

CHEMICALLY POLISHED AND ANODIZED ALUMINIUM IS INCREASINGLY USED FOR BRIGHT TRIM. THE DUCTILITY OF THE MATERIAL ALLOWS COMPONENTS SUCH AS NAVE PLATES TO BE SPUN, AS SHOWN ABOVE

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DESIGN MATERIALS **AUTOMOBILE ENGINEER** PRODUCTION METHODS WORKS EQUIPMENT

Vehicle Lighting

NIGHT driving probably presents more problems in Great Britain than in most other countries, because of the high traffic density and the frequent variations in road conditions, including street lighting. At road junctions, flashing indicators, especially those at the side and rear of the vehicle, can be a menace from the point of view of dazzle at night, but they have to be bright enough to be seen clearly on sunny days. It follows, therefore, that they either ought to be wired in series with the side lamps, or some extra resistance should be introduced into their circuits when the side lamps are on.

Dazzle from oncoming traffic is probably the most prevalent single danger in driving at night. For this, both the roads and the vehicles are responsible. The ideal road would, of course, have the opposing streams of traffic so widely separated that headlamp dazzle would be eliminated. In our congested islands, such Utopian planning is scarcely practicable as a general rule, but the wide dividing strip of the new motorways is certain to be beneficial. Also, on dual carriageway roads with a relatively narrow division, there is a good case for the more general planting of hedges between the carriageways.

The greater part of our highway system, however, will continue to be of the single carriageway type, so that the problem of dazzle must remain a major one. A considerable amount of research work has been carried out with polarized light, using lamp lenses and windscreens with their planes of polarization mutually at right-angles. Although the results have been good, the scheme is hardly practicable: to be successful it would require 100 per cent adoption, which would necessitate an expensive conversion on all vehicles, while motor cyclists and cyclists would need to wear polarizing goggles. Also, polarized lamp lenses absorb an appreciable amount of the light emitted by the bulb, so that more powerful bulbs would have to be fitted for a given intensity of illumination. It follows that a greater electrical output would be necessary, and that might mean a larger and more costly generator.

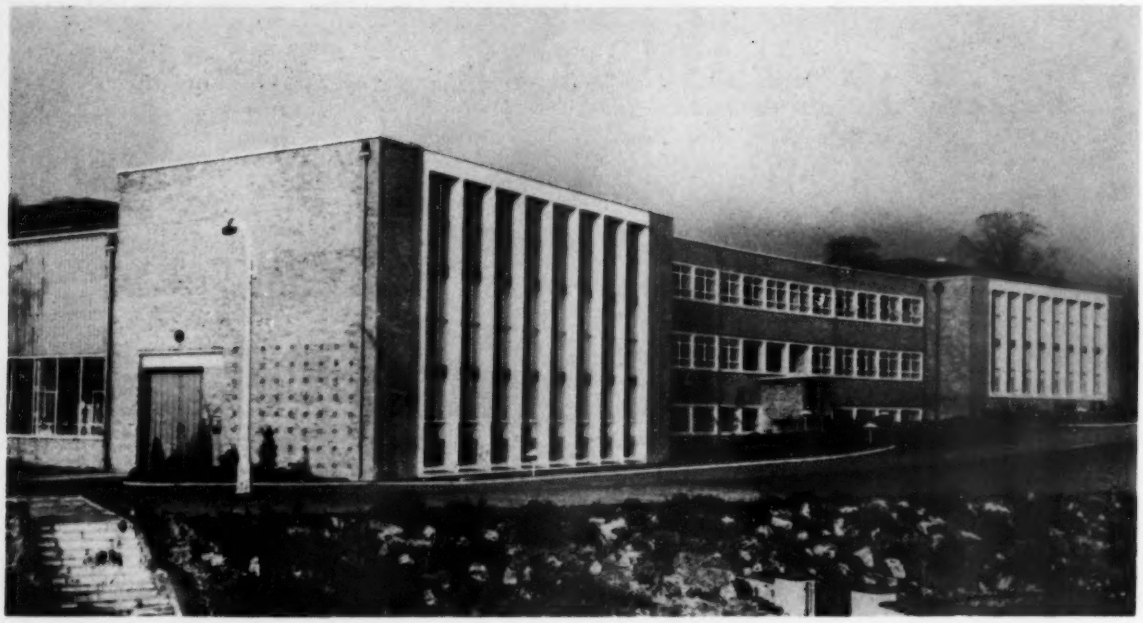
Better prospects are offered by the four-lamp system. Now coming into general use in the U.S.A., this system has already been introduced in Great Britain for heavy vehicles, and is known to be under development for private cars. In it, each of the normal two headlamps is replaced by a pair of smaller lamps, mounted one above the other, side by side or in an intermediate, oblique grouping. The upper or outer lamp of each pair has a two-filament bulb, while the other has a single-filament bulb.

When the switch is moved to the dipped beam position, only the two twin-filament lamps are in use, and the beams are provided by their on-focus filaments. These lamp units are designed specifically to furnish the most satisfactory light pattern for this purpose. With the switch in the main beam position, however, all four lamps are in action. The long-range illumination is provided by the single-filament bulbs, the lamp units of which also are designed specifically for their duty, and additional illumination of the foreground is given by the off-focus filaments in the other pair of lamps.

With the currently employed system, of course, some reduction in the efficiency of both the main and the dipped beams cannot be avoided, owing to the need for a compromise to suit the two conditions. So marked is the improvement in illumination effected by the conversion to four headlamps, that the system is likely to oust the present one on the more expensive type of car. The higher cost of the four-lamp installation may be an embarrassment to the manufacturers of quantity-produced cars, but it is to be hoped that these firms will give serious consideration to the system.

So far as styling is concerned, paired lamps obviously cannot be accommodated in the frontal aspect of a small car so easily as in that of a large one. Given the necessary space, it might be possible to evolve a design that could incorporate either two or four lamps, merely by the provision of alternative lamp housings. Thus, the twin-lamp layout could form the standard specification, with four lamps as an optional extra. In effect, this has already been done on the new Fiat 1800 car. Possibly a larger generator would be necessary to cope with a four-lamp requirement of, perhaps, 150 watts.

Whereas the four-lamp system can do much to give satisfactory illumination in the face of oncoming traffic, there remains the minor menace of the driver who fails to dip his lamps. This problem might be effectively solved by the automatic dipping device now available in the U.S.A., provided it were widely adopted. The principle of operation of this device, which is based on a light-sensitive photo-multiplier tube, was described briefly in the February, 1959, issue of *Automobile Engineer*. The automatic control can be overridden to permit signalling with the main beam. Since the incorporation of this equipment would probably add about 2 per cent to the cost of the average medium-size car, there is little likelihood of its adoption as standard equipment in the near future. Nevertheless, it could have a market as an accessory for those motorists who like ingenious gadgets that simplify driving and, in any case, in view of the modern trend towards fully automatic control, it merits consideration.



A view of the imposing new Ferodo research centre at Chapel-en-le-Frith. In the middle of the building is the administration office block

Ferodo Research Centre

New Establishment Provides Comprehensive Facilities for the Investigation of Friction and Wear Phenomena, with Particular Reference to Brake Linings

AT Chapel-en-le-Frith, Derbyshire, Ferodo Ltd. have recently opened a new research centre, which is claimed by that company to have greater resources than any comparable establishment. The centre occupies an imposing and handsome three-storey building adjacent to the main factory. It is stated that the cost of the building was £¾ million and that it contains equipment valued at a further £½ million. Much of this equipment, however, is not new but was in use elsewhere in the factory before the previously dispersed research and experimental sections were amalgamated into the present, almost self-contained, unit. Although much of the effort of the establishment must inevitably be directed towards the improvement of road vehicle brakes, the Ferodo organization is concerned with all applications where kinetic energy has to be dissipated as heat. Aircraft, railways, mining, agriculture, earth moving and general industry are all fields of activity in which the lessons learned at the centre may be applied.

Photomicrograph of rubbed metal surface obtained during friction research. Magnification is greater vertically than horizontally

The decision to invest a large capital sum for the provision of these research facilities resulted mainly from the rapid post-war increase in the demands made on automotive brakes. Among the major factors that have led to these increased demands are greater engine power and improved suspension and handling, all of which make higher speeds possible. Although better aerodynamic form also has resulted in higher performance, it has given rise to shrouding of the brakes from the cooling draught. Moreover, wheel diameters on cars have been reduced to a marked extent, and with them the size of drum that can be accommodated. Finally, the opening of motor ways, on which all vehicles can travel at high speeds, must inevitably result before long in the need for better braking equipment on lorries and coaches: what is adequate for speeds up to the statutory 30 m.p.h. is unlikely to suffice for double that figure.

There are four main sections into which the department's work can be sub-divided: fundamental research on friction and raw materials; the development of improved types of brake linings; the testing of such linings in the laboratory and on the road; and experimental production. This last section covers not only the evolving of suitable production methods for new materials but also with improving those methods already in use. The building is laid out to provide full scope for all four sections, with the administration

office block in the middle of the frontage, flanked on one side by the test house and on the other by the experimental production wing. Centrally, at the rear of the administration block, is a third wing housing the various laboratories.

Fundamental research

In the past, much of the work of developing improved lining materials has been largely empirical, because of the lack of knowledge of the nature of surface friction. The atom, the molecule and the molecular arrangement that makes up the solid have been closely studied, but less has been done on investigating the effects arising at the boundary of the solid. It is self-evident that a better understanding of the nature of surface friction must result in greater ability to predict the probable behaviour of brake lining materials. Surface friction is therefore being investigated as a laboratory problem by a group of physicists.

Among the matters now being studied are: what actually occurs at the contact area, and the effect of varying the load; the temperatures reached during sliding friction; the relationships between friction and wear, surface roughness and friction, and surface roughness and wear; also, how wear particles are formed and what physical and chemical changes they have undergone. The progress made so far in this department is sufficiently encouraging to suggest that really important advances will be made within the next few years.

Study of the raw materials used in brake lining manufacture is concentrated mainly on asbestos and resins. As long ago as 1908, the company changed over from cotton-

base to asbestos-base material because it not only has a high heat resistance but, being a fibrous mineral, has the necessary combination of flexibility and strength. White or chrysotile asbestos is by far the most commonly used variety. A hydrated silicate of magnesia, mined principally in Canada and Africa, it has the approximate formula of $Mg_3Si_2O_5(OH)_4$. In its long fibre form it is spun into yarn, which is the basis of the woven type of lining; moulded linings are based on the short fibre form of the asbestos. The individual fibres are silky, flexible and finer than any synthetic fibre.

The molecular structure of types of asbestos other than chrysotile has been known for many years as a result of X-ray crystallography, but in the investigation of chrysotile, this method of study gave rise to considerable difficulties. However, recent work in the Ferodo laboratories[1,2,3,4] has resolved these difficulties and has revealed that the fibres are predominantly tubes, each consisting of co-axial, cylindrical layers of atoms. There are usually about ten of these layers, the outermost measuring about one micro-inch in diameter and the innermost about half that figure. The manner in which the layers are stacked varies to some extent from one mine to another, and results in minor variations in the size and properties of the fibres.

On their own, asbestos fibres clearly have not the necessary physical properties for a brake lining, so it is necessary to employ a resin to bond the lining constituents together. The resins used are basically of the phenol-formaldehyde, thermo-setting type, and various vegetable oils may in some cases be added during the manufacture of the resin. Precise analysis of the complex new materials is essential, and for the separation of the constituents, chromatography is the most effective method. The mixture is passed through a column packed with an adsorbent medium on which the various constituents are retained. Coloured constituents form coloured zones in the column, whereas apparently colourless zones may be rendered visible by the use of ultra-violet light.

Each zone is collected in a different tube and the solvent is then evaporated. To determine the molecular structure of the various constituents, their molecular weights are measured, and they are analysed by means of an infra-red spectrometer. This splits up the infra-red radiations into a spectrum; the energy at each point of the spectrum is detected and amplified, and a graph of it drawn automatically. Since different substances have different energy patterns in the spectrum, qualitative and quantitative analysis is possible. By varying the resin formula and the proportion of resin to other ingredients, the characteristics of the final product can be altered considerably. However, a new resin can only be adopted if it is suitable for large-scale production. For example, a resin with a critical cure time might be difficult to control under factory conditions.

Developing a lining

Usually, the starting point in the evolution of a new lining is the available information on the required level of friction, the temperatures and speeds involved, the rubbing surfaces, and the braking system employed, together with any other relevant details. This information may be supplied by the vehicle designer or may be acquired by Ferodo technicians. Indeed, its acquisition has involved the laboratories in much original work on the subject of surface temperature[5,6]. Given this information, the chemists and physicists decide

Left: Chromatographic apparatus used for the analysis of resins. In the illustration below, a Weissenberg goniometer is being set up to investigate the molecular structure of chrysotile asbestos

jointly on the type of lining material and the ingredients most likely to produce the desired results. Small sample batches of linings are then made up; in some of them the proportions of the raw materials are varied, while for others the method of processing differs. Full records are kept of all such variations. These sample linings may, of course, be of either the woven or the moulded type, depending on the particular application.

The main reason for the progressive increase in popularity of the moulded lining for automobile applications is the greater ease with which it can be tailored to suit the particular requirements. Since the ingredients can be varied to a much larger extent than is possible with woven material, a better compromise can be obtained, but only where the conditions of usage are fairly closely defined, as is the case where automobile brakes are concerned. The variety of conditions that can be specified, however, demands that an equally wide variety of moulded materials be available, but each inevitably is of a highly specialized nature. A woven lining is inherently more versatile, although it cannot have as good a performance in any particular application as the most suitable moulded lining. It follows that, where the conditions are not known in advance, as, for example, in industrial brakes sold off the shelf, the woven lining still offers considerable advantages.

To determine the basic characteristics of the samples, though not necessarily their suitability for brake or clutch linings, they are subjected to a series of laboratory tests, among them a test for friction and wear. A sample is mounted on one plate which is rotated at a uniform speed while pressed against another plate at a predetermined load. From the torque on the second plate, the coefficient of friction of the material can be calculated. Wear is assessed by weighing the sample before and after running. If the lining is to be bonded to the shoe, its suitability for this is tested by progressively increasing the shearing load on the lining until the bond breaks down, and noting the load required to produce failure.

This initial testing may reveal the lining to be unpromising, in which case it is scrapped. If the results are satisfactory, other sample batches are prepared, with such modifications to the resin content or processing as may have been suggested by the testing. The procedure is repeated as necessary until the material's performance matches the specification

Upper left: The earliest stage in the evolution of a new brake lining is the preparation of test samples from asbestos, resin and various modifying agents

Centre: A sample of friction material being inserted between the plates of a machine on which the characteristics of friction and wear are investigated

Left: A general view of the extensive test house, showing some of the range of inertia dynamometers that are used

already laid down, at which stage the test house takes over.

Before discussing the methods employed there, it is interesting to consider the part played in the research scheme by the technical sales department. In addition to its sales activities, the department has to endeavour to forecast market requirements, in the light of experience and current trends, and to make recommendations to the research department, to form the basis of long-term investigations. If any urgent problem arises, perhaps as the result of a complaint from a customer firm, this is at once referred to the research department for a solution. In many cases there is naturally a considerable degree of empiricism involved, and to obtain the right answer may be merely a matter of days, or it may equally well take several weeks.

The test house

While test machines cannot be a substitute for vehicle operation on the road, they can be made to simulate closely the requisite conditions which, moreover, can be strictly controlled. Also, a test fleet must of necessity be restricted to a reasonable number of vehicles and is less economical in time and manpower than is machine testing. The latter therefore forms a useful second-stage filter, for the rejection of the less suitable lining materials, between the laboratory and the vehicle development stages.

There are two main reasons for the fact that machine testing is more economical than vehicle testing. In the first place, forced cooling of the brakes, by means of fans, can be employed, so that the application cycle time can be reduced. Secondly, day and night testing is made possible by the use of automatic controls; on the road or test track, such a schedule would demand a team of drivers.

Test house procedure and equipment were dealt with in detail in an earlier article in *Automobile Engineer*[7]. Consequently, there is no need at this juncture for more than a brief recapitulation. The large bulk of the testing is carried out on what are known as inertia dynamometers. A dynamometer of this type comprises a variable-speed electric motor, a battery of flywheels and a torque reaction member. The first flywheel is keyed to the shaft driven by the motor; the others float on the shaft but can be locked to it as required. On the other end of the shaft is mounted the brake drum or disc, while the shoe plate assembly or caliper is attached to the torque reaction member of the test machine.

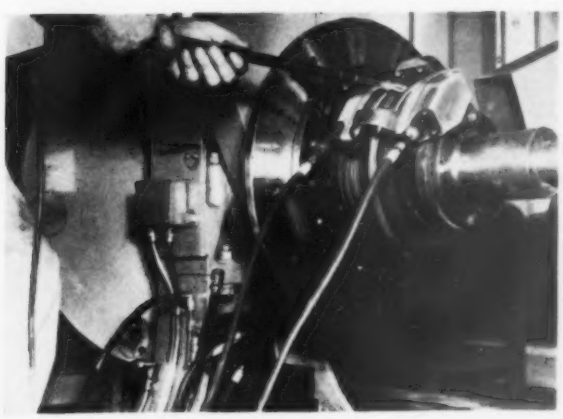
By choosing a suitable number of flywheels, the kinetic energy of the system can be adjusted to approximate, at the appropriate shaft speed, to that of an actual vehicle. Not only the mass of the vehicle but also the braking ratio between front and rear wheels has, of course, to be estimated and taken into consideration for this purpose. Strain gauges or hydraulic devices may be used to measure the torque applied to the reaction member by the brake, which is cooled by a fan if necessary.

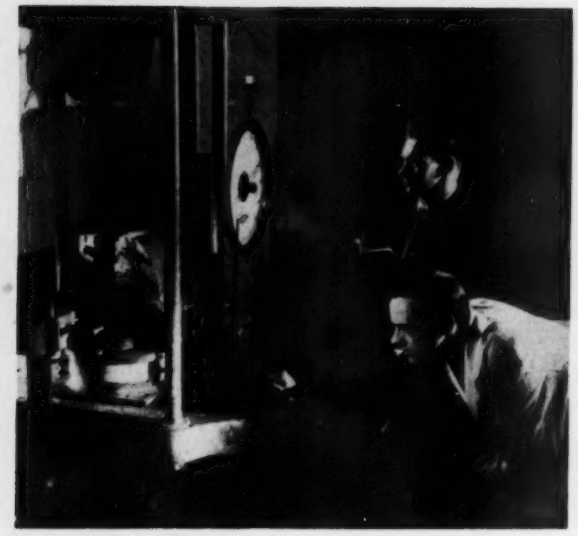
Electronic equipment is widely employed in the test house, as on this typical, comprehensive control panel for an inertia dynamometer

The basic test procedure is to run up the motor to a speed corresponding to the desired road speed of the vehicle, declutch it and apply the brake. However, because of the considerable number of factors to be evaluated in connection with any one lining material, a typical test schedule may involve as many as twelve groups, each of between 30 and 100 stops under particular conditions. A moderate fade test is normally carried out part way through the schedule and a severe fade test at the end.

Among the faults that may be revealed by use of the inertia dynamometers are variations in frictional coefficient during each brake application, reduced friction level after fade;

Below: Using a portable thermocouple to get a temperature reading on a disc brake. Right: Setting up a motor cycle brake on one of the smaller inertia dynamometers installed in the Ferodo test house



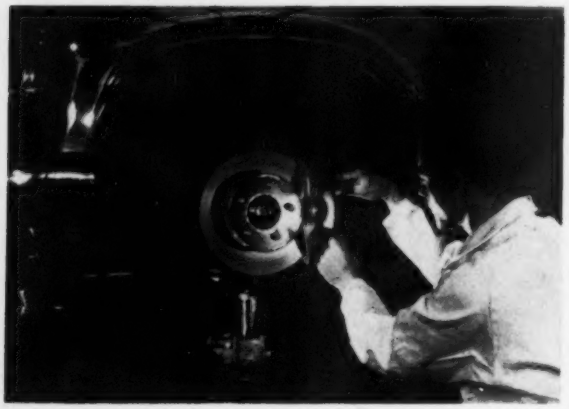


The machine shown on the left is used to assess the strength of the bond between a bonded-on lining and its shoe. Right: A bus rear brake assembly being removed from one of the larger inertia machines for inspection; on the drum of the brake unit is an anti-squeal band

undesirable effects of temperature or speed on friction; inadequate resistance to moderate or severe fade conditions; delayed fade or severe over-recovery from fade. When the possibilities of a new material are being assessed, the test results are, of course, related to the expected duty; for example, high fade resistance is not an essential for a low-performance family type car. The wear rate of a lining is normally measured by the thickness reduction during the tests, but measurements of the weight loss are also taken: each of these methods serves as a check on the accuracy of the other.

Instrumentation for such testing is comprehensive, and the human element is eliminated as far as possible by automatic control panels, built by the Ferodo electronics and machine control technicians. It is possible to preselect, over a sequence of up to 2,500 brake applications, a variety of conditions, including speed, time cycle, braking torque and cooling setting. The latest panels have a triple dekatron counter to record braking times to the nearest 0·01 sec. Temperatures are sensed by thermocouples embedded in the brake drum or disc and can be graphically recorded continuously throughout the test, as well as indicated on a scale mounted on the instrument panel of the machine.

Vehicle testing is an important part of the research activities. Here a mechanic removes an experimental friction pad from a disc brake



A wide range of inertia values is covered by the various types of dynamometer, most of which can be run under conditions of either constant pressure or constant torque. In the first case, the load on the lining is constant and, because of the effect of temperature changes on the coefficient of friction, the rate of deceleration varies during each stop. Under the constant torque condition of running, variations in the coefficient during the stop are automatically compensated, so that the rate of energy dissipation does not vary. Since, on any given test, the same temperature will be reached by any lining material, this method is particularly valuable for purposes of comparison.

Clutch testing

The behaviour of clutch facings is investigated on two types of machine, one of which simulates normal engagement and the other slip at full torque. On the first type, two flywheels are mounted on a common shaft to which are attached two standard 10 in clutches. An electric motor drives the spinner of one clutch, while that of the other clutch is anchored. Operation of the machine is automatically controlled on a 12 sec cycle, comprising acceleration of the assembly up to motor speed, by engaging the first clutch, and then releasing this clutch and engaging the other to bring the flywheel to rest. Thus, both of the clutches do virtually the same amount of work. The wear of their facings is measured after 10,000 cycles, and the coefficient of friction of the facings is measured at intervals during the test.

For slip testing, an electric motor drives a standard engine clutch and flywheel assembly; rotation of the spinner is prevented by means of a lever and piston hydraulically connected to a pressure recorder. A spinner of standard thickness is used for the calibration of the clutch spring pressure. The motor is run up and then the clutch is automatically engaged. From the recorded hydraulic pressure and the average spring pressure throughout the test, the coefficient of friction of the facing material can be determined. The test normally consists of nine slips of ten seconds' duration.

Another machine used in the testing of clutch materials determines the rotational speed at which the facing disintegrates. The clutch disc is clamped to a faceplate mounted on a shaft; the assembly is installed in a safety

chamber and the shaft is driven by a variable-speed motor and step-up drive giving a maximum speed of 25,000 r.p.m. An average figure for the disintegration of a facing is 19,000 r.p.m., so clearly there is an ample safety margin.

Testing on vehicles

If a lining material gives satisfactory results in the test house, the next stage is to try it in a suitable vehicle of the Ferodo test fleet. Because of the specialized nature of the moulded type of lining, it is necessary to have a wide variety of vehicles, in order that test conditions can be selected to resemble those for which the lining was designed. The fleet therefore ranges from motor cycles, through small and large saloon cars, and high-performance sports cars, to commercial vehicles and buses. All are fitted with instruments to enable full information to be obtained on the behaviour of the lining, and several of the cars are equipped with disc brakes. To reproduce as far as possible typical operating conditions, test circuits are mapped out in the Derbyshire Peak District and in the neighbouring Cheshire plains. The streets of Manchester and Stockport provide ample facilities for town running.

Again, this subject was fully covered in the article mentioned earlier, so a detailed description is not needed here, but there are several points worthy of comment. The first of these is the method of calibrating speedometers[8], which of course is the prime essential for performance testing. Calibration is carried out from 10 m.p.h. up to 60 m.p.h., if necessary, and is done by means of a photocell and concentric light source mounted on the rear bumper of the vehicle. The light from the source falls on the road, whence it is reflected in sequence by two mirrors placed 40 ft apart; the pulses so obtained from the photocell are used to start and stop an electric chronograph in the vehicle. These mirrors are $\frac{1}{2}$ in wide in the direction of travel and are 15 in long. A white guide line on the road surface assists the driver to place his vehicle correctly in relation to the mirrors.

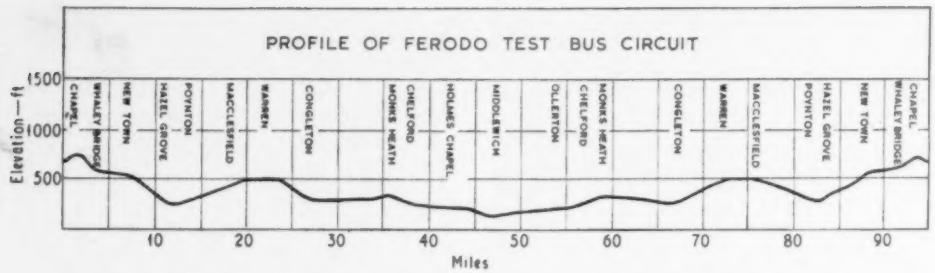
Various types of decelerometer are used, and brake pedal load is measured either directly, by a pressometer, or indirectly by means of a pressure gauge in the brake pipe line. Other instruments indicate the lining temperatures and the number and duration of brake applications. A recent development is the use of cameras for certain tests: this conserves manpower by making it unnecessary to carry an observer. Two systems are used, according to the nature of the test. Where only a periodic record is needed, the camera is set to expose one frame every three minutes on the appropriate instruments, but where the behaviour during individual stops is to be studied, the camera runs at the normal cinematograph speed of eight frames per second.

The instrumentation described suffices for normal development testing, but it may from time to time be found desirable to run a series of special tests. An example of such a series was detailed in a paper read before the Institution of Mechanical Engineers by the company's then engineering research manager[9]. The nature of these tests was such that the instrumentation had to be devised specially for the purpose. It comprised a continuously running chart recorder with pens for drum speed, rate of working of the brakes, deceleration and drum temperature.

In routine testing, linings are normally subjected to four groups of tests: performance, fade and recovery, water recovery and variations of friction with speed. The vehicle is first driven for a few hundred miles to ensure that the linings have properly bedded in, after which the shoes are removed to enable the initial measurements for weight and thickness loss to be taken. After reassembly of the brakes, the performance test is carried out on a level road. It comprises a series of stops from the same speed at suitable increments of pedal pressure; the deceleration is recorded in each case, and the brakes are allowed to cool between applications.

The second stage is the covering of about 500 miles on the road, with the brakes worked fairly hard. During this spell, the general behaviour of the brakes is noted, as are any faults such as squeal or grabbing. Then the frictional performance is again checked before the other tests are

Included in the Ferodo test fleet is a bus, which is loaded to simulate double-decker conditions. The instruments and the control panel are seen in the upper illustration



Reproduction of the profile of a typical test bus circuit in the Derbyshire Peak District and the Cheshire plains

embarked upon. For the speed/friction test, also done on a level road, the pedal load is kept the same for each stop but the speed is progressively increased to something near the maximum of the vehicle. Again the deceleration is noted.

Fade and recovery tests on cars and motor cycles are usually carried out on the company's own 700 yd test track, converted from a section of old tramway near the factory. The vehicle is accelerated to a relatively high speed and is then braked to a standstill at a predetermined deceleration, while the pedal effort is recorded. Frequent repetition of the cycle raises the temperature of the linings to a level equal to or exceeding that which could be reached in service. In a typical test, fifty 0·5g stops might be carried out from 50 m.p.h. on a one-minute cycle.

After this fade test, a check is made of the recovery characteristics on cooling. The stops are made from a lower speed than before, to avoid the input of too much heat to the brakes, and on an increasing time cycle as the temperature falls. This test may reveal not only normal fade but also delayed fade or over-recovery; the latter condition is that in which, during cooling from fade temperatures, the coefficient of friction rises above its cold value. If present to any marked degree, either of these two characteristics is clearly undesirable.

Because of the difficulty of putting enough energy into the brakes of a commercial vehicle or bus by braking on a level road, fade tests on such vehicles are usually done on a carefully chosen hill. The vehicle is braked to a standstill from a specified speed at a number of selected points on the hill. A check of the hand brake is also carried out, and fade recovery checks follow the same lines as on cars.

The water recovery test consists simply of a series of stops at a predetermined pedal effort after immersion of the brakes in water. An indication of the recovery characteristics is given by the changes in deceleration rate as the brakes dry out. The four test groups are followed by further road mileage, with performance and possibly fade tests repeated at intervals. During this additional mileage, the drums are examined for heat spotting and scoring; any tendency of the lining to glaze under light duties is indicated by the performance tests. Regular physical checks on the linings reveal any unduly rapid wear.

In terms of braking performance, the public service vehicle differs from any other category, and it is typical of the thorough approach by Ferodo that the test fleet should include an actual bus. This bus comprises a single-deck body on the chassis of a double-deck bus; the body is weighted to simulate the double-deck condition of full passenger load. Full test instrumentation is installed, and is read by an observer in the passenger compartment. To represent typical running conditions, an electronically controlled buzzer system gives start and stop signals to the driver, and these can be repeated at any desired frequency. A test circuit diagram is reproduced on this page.

Field testing

When a new lining has passed satisfactorily through all the stages mentioned, unlike the many other samples that have failed to pass the tests and have been discarded, it will then probably be tested in the field. Where it is intended for a vehicle in quantity production, both the vehicle manufacturer and the brake manufacturer conduct tests, with the co-operation of Ferodo. If the new lining is not intended specifically for a new model under development, its testing

A 700 yard test track has been built on a disused tramway near the factory; the Chevrolet seen in the illustration is carrying out a fade test

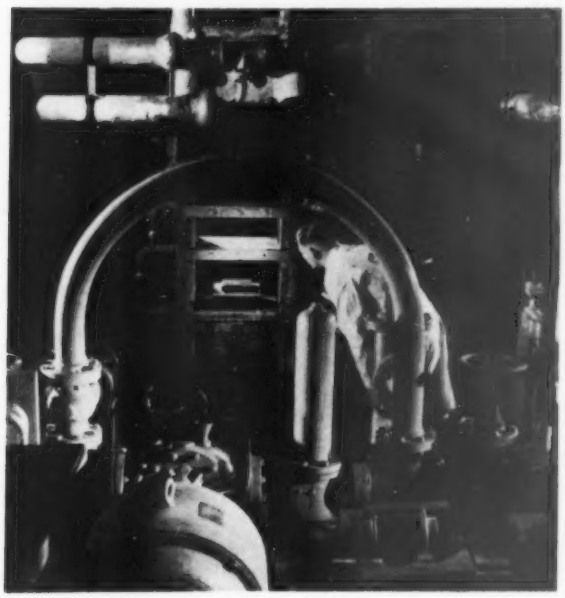
may be spread over a wide range of vehicles, to assess its behaviour and performance in a variety of circumstances.

Such testing is carried out under fairly well controlled conditions. However, control is more difficult in the case of linings supplied to fleet operators for them to test in the field, because of the large number of variables involved. Provided, though, the test results are very carefully analysed in the light of the known conditions in which the vehicles are running, useful results can be achieved.

Other friction materials

Until recently, asbestos-base friction materials have been the almost exclusive subject of research and development in the Ferodo laboratories. Nowadays, however, there are numerous duties in which the temperature and strength requirements are beyond the scope of those materials.

Below: One of the presses for the experimental production of linings



Examples are the clutches of earth-moving equipment and tractors, also those used in certain automatic transmission systems. It is in these fields that powder metallurgy is playing an increasing part. The sintered linings used on the applications mentioned consists of mineral fillers distributed throughout a metallic matrix. Pressure sintering at red heat, in a reducing atmosphere, is employed to increase the density of the material and to bond it to the supporting member.

Research on lining materials of this type covers both the component powders and their processing. The first stage is the analysis of particle size distribution, effected by the Ro-tap sieve method, sedimentation balance weighing and microscopic counting. In the microscopic counting operation, representative samples of powder are compared directly by means of special eye-piece graticules. Other work in the department is devoted to improving methods of compacting, handling and sintering the powders.

Perhaps even more promising are the cerametallic materials, in which a metallic phase is introduced into a ceramic body to improve its mechanical properties and to facilitate fabrication. Such materials, by comparison with sintered metal linings, have greater resistance to heat and wear, and a higher frictional coefficient. The basic method of manufacture is to mill the metal and ceramic powders and to compact and sinter them at a high temperature. Improved methods of fabrication are the main objective of the present research programme.

Above: This hydraulic press is used in the experimental production laboratory to compact metallic powders before they are sintered

Experimental production laboratory

Before large-scale production of a newly developed lining material can begin, laboratory techniques must be translated into factory processes. This is one of the functions of the experimental production laboratory, which contains more than a hundred machines. However, since the general aim of the laboratory is at devising the most economical and efficient methods of manufacture, its work is not only concerned with new products but also with the improvement of existing methods. An important aspect of the activities is the development of suitable plant, because this is frequently of too specialized a nature to be obtainable from outside the factory.

In the case of new linings, means have to be evolved of producing the material in bulk, while maintaining the quality of the original samples. For moulded materials, satisfactory mixing of the constituents has to be ensured, and the most suitable moulding, curing and finishing techniques established. The production of woven materials, on the other hand, involves problems such as the manipulation of the fabric and the method of impregnation. Where improvements to existing techniques are being investigated, it is essential that any changes made should not adversely affect the chemical and physical properties of the lining material.

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Before the engines are dismantled they are passed through the more distant of the two washing machines; subsequently, the dismantled components are passed through the machine that can be seen in front of it

A.E.C. Engine Replacement Service

A Recently Installed Plant for Reconditioning the Diesel Units of Goods and Passenger Vehicles

FOR many years A.E.C., of Southall, Middlesex, has operated a scheme whereby used engines of its manufacture can be part-exchanged for completely reconditioned units, and operators of all types of vehicles have regularly availed themselves of those facilities. As a result of the continuing trend towards extension of the operating period between major overhauls, the number of operators who participate in the replacement scheme is increasing. This is because the majority now find it more economical to do so than to undertake the work in their own plant. As a consequence of the increased demand, A.E.C. has found it necessary to install a modern engine reconditioning plant, with comprehensive facilities, at Southall.

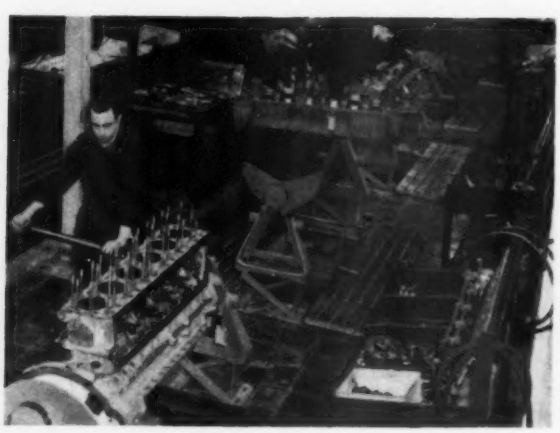
This new shop has a floor area of approximately 30,000 ft^2, and is equipped with the latest specialized plant for engine rebuilding. It is now fully in operation and its resources are adequate to meet the expected demands. Certain operators, notably those with very large fleets, may contend that they can overhaul their own engines more economically. Nevertheless, it would seem obvious that engines that have been completely reconditioned and rebuilt by the manufacturers, with their specialized resources for inspection, gauging, machining and testing, are likely to give the best possible service. Factory-reconditioned engines are rebuilt to dimensional standards, and a relatively large proportion of new components is incorporated. They are then fully tested on a dynamometer, to ensure that their performance is equal to that specified for new engines, and they are dispatched under a twelve-month guarantee.

General procedure

The dismantling, inspection and re-assembly of the engines in the plant, of course, follows a carefully planned routine. Before it is stripped, the complete power unit is conveyed through a Curran washing machine; the traverse taking thirty minutes. In this machine the engine is sprayed with a hot solution of Solvex, supplied in crystal form by Fletcher Miller Ltd. The used solution is collected in a sump and passed through a filter ready for recirculation. It is necessary to clean the filter only once per week.

Specially designed mobile racks are used in the marshalling stores section to save time in the issue of new and reconditioned components

All the reconditioned units are assembled again on special stands that are adjustable to accommodate the different types of engine



At the next stage, all sub-assemblies are removed and passed through another Curran washing machine. They are then completely dismantled and the individual components again travel through the washing machine. In these last two cleansing operations, liquid Solvex is used, but Ardrox, supplied by Brent Chemical Products Ltd., is employed for the removal of heavy carbon deposits. Absolute cleanness of components prior to inspection is, of course, of paramount importance.

All components are then passed to the view room, where they are systematically inspected and those items unsuitable for further use are scrapped. The remainder are transferred to a marshalling stores for issue, together with the appropriate new components, in type batches to the various sections in the assembly shop, where they are built up in sub-assembly form. The sub-assemblies are then returned to the marshalling stores for issue to the engine main assembly line. This procedure ensures full control of the flow of sub-assemblies to the line, and renders it unnecessary for productive workers to leave the assembly line or bench.

Component testing and reconditioning

All components are subjected to detailed examination. If bowed crankshafts are received, they are straightened, provided it is practicable and desirable to do so, but otherwise they are scrapped. Crankshafts are crack-tested on Fel-Electric equipment before they are reground on a battery of Churchill grinders. There are four of these machines, two for main journals and two for the crankpins. The journals and pins are ground to an appropriate standard undersize diameter. After the grinding operations the shafts are again inspected to ensure that they conform to the appropriate standards set by A.E.C.

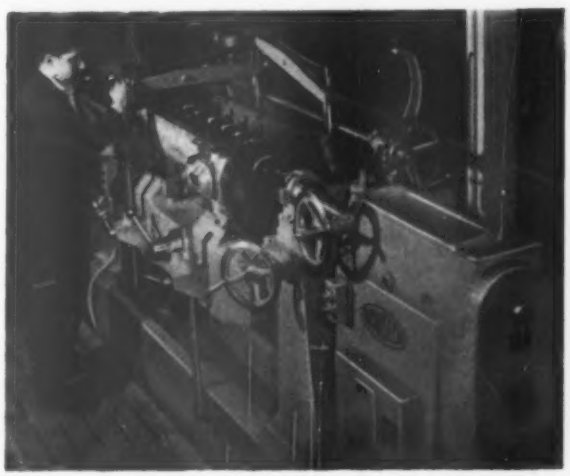
Adjacent to the crankshaft grinders is a bay in which main bearings that are not of the prefinished type are fitted to the crankcases and line-bored in a Krauseco machine. After the bearings have been bored they have a layer of tin, about 0·0001 in thick, deposited in them and are then lead-flashed to give an overall deposited thickness of approximately 0·0005 in. Engines of monobloc construction that are currently in production are, of course, fitted with precision type prefinished bearings.

All cylinder-block rebuilding is effected in one section of the shop. Operations include grinding the joint face on a Snow machine, pressing in new cylinder liners, and honing the bores to size on Kitchen and Wade machines. The jackets of both engine blocks and separate cylinder blocks are pressure-tested before the liners are fitted into them.

On the cylinder head, the first operation is the surface grinding of the joint face. This is done on a Lumsden machine. After this operation the head travels along a roller track to a line of Archdale, and Kitchen and Wade, pillar and radial drills for machining and the fitting of valve-seat inserts, injector sheaths, and other items. A P. J. Hare press is used for inserting the valve seats. For this operation, the cylinder heads are placed on a platen on the worktable. This platen has a hole drilled horizontally from one edge to the centre, where it joins a vertical hole drilled from its lower face. A flexible pipe is connected to the drilled duct, at the edge, to supply air under pressure, controlled by a push-button on the connection, to lift the platen a fraction of a thousandth of an inch clear of the worktable so that it can be slid easily to locate the head relative to the ram of the press.

Next, the head is passed along a roller track into the assembly section, where all operations are carried out on benches adjacent to the track. Inspection is made at intermediate stations along the line. The profiles of the end-pads of the rockers are re-formed on a Norton surface grinder. Valve springs are inspected and checked for rate at the initial dismantling stage, when they are selectively grouped and painted for identification in respect of rate.

The connecting-rod section of the shop is equipped with a lathe for rough-boring the bearings, and special jigs are



Above: A new Krauseco machine has been installed for line boring all main bearings, except those of the pre-finished type

Right: After the cylinder head joint faces have been surface ground, the components travel by roller track to a line of pillar and radial drills for machining and fitting valve-seat inserts and other parts

employed to reduce set-up time. After the rough-boring operation, the rod assemblies are mounted on a jig and their bores are broached locally to relieve a small area adjacent to the abutting faces of the bearing on each side. Then they are finish-bored in two Heald Borematic machines, which deal with both the big- and small-end bearings in one operation and thus ensure accuracy with regard to the spacing of the centres, and also parallelism. New bolts are always fitted to the big-ends, to avoid any possibility of fatigue failures. A large number of connecting rods is handled in this section, since it supplies the needs not only of the engine reconditioning programme but also of the spares department.

Fuel-injection equipment is reconditioned in a separate shop housed within the main workshop. Hartridge fuel-pump test machines and Merlin Servicemasters are employed. To maintain scrupulous cleanliness in the pump and injector reconditioning shop, the stripping and cleaning bay is separated from it.

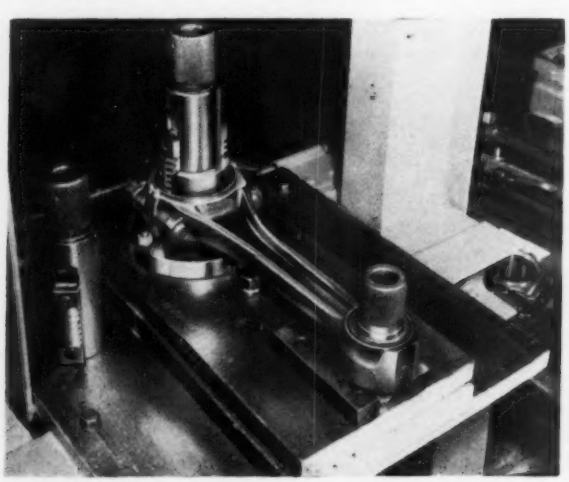
Adjacent to the injection-equipment section is the store from which new material is issued to the adjoining marshalling store. In the marshalling store, specially designed mobile racks are used. On them are placed all the components required to form a complete assembly kit ready for issue to the appropriate position on the main assembly line.

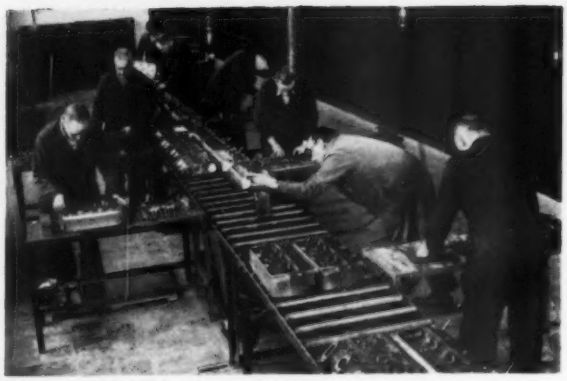
Engine assembly is effected on special stands manufactured by A.E.C. Each stand can be adjusted to accommodate engines of different length. Above the assembly line is an overhead runway for power-operated hoists. The arrangement of the runway is such that when the engines are completed they can be removed with a minimum amount of interference with the remainder of the line. After removal they are loaded on to an electric truck for transportation to the test house. The test that is carried out is equivalent to that given to new engines from the company's production lines, and the same standards of performance are specified

Table: STANDARD CHARGES FOR RECONDITIONING ENGINES

A.V.410 and A.V.470, with exhauster	£205
A.V.410 and A.V.470, with compressor	£215
AH.410 and AH.470, with exhauster	£205
AH.410 and AH.470, with compressor	£215
7·7 litre engine	£260
9·6 litre engine with standard injection pump	£250
9·6-litre engine with hydraulically governed injection pump	£275
11·3-litre engine with standard injection pump	£260
11·3-litre engine with hydraulically governed injection pump	£285

A connecting rod assembly, with the broach in its big end, mounted on a jig ready for relieving the bore adjacent to the abutting faces





The cylinder heads are passed into the assembly section, where all operations are carried out on benches adjacent to the roller track

for the reconditioned power units. All the test benches are equipped with Heenan and Froude dynamometers. The reconditioned units are run-in under light load before they are operated at full power; the whole series of tests on each engine occupying a full working day. After the engines have been tested, they are returned to the main shop for a final check and are then spray painted in a wet-back booth.

Operation of the exchange scheme

Operators wishing to take part in the exchange scheme place their order with a depot, or direct with the Southall Service Department. The latest date that the unit is required must be specified and also whether the used engine is to be delivered and a reconditioned engine collected, or the vehicle is being sent to the factory for the replacement engine to be installed. Normally, the engine is accepted less the dynamo, starter, exhaust manifold, fly-wheel and clutch. Operators who prefer to carry out their own fuel pump overhauls are asked to state that in their order, and an allowance is made in respect of the charge for the overhaul. The current charges are as shown in the accompanying table.

In special instances it is possible for the original engine to be reconditioned and returned to the operator, but normally a replacement unit is supplied. There are no charges additional to the standard ones listed, except in the unlikely event that the crankcase, cylinder block or crankshaft of the engine returned by the operator has to be replaced by a new component. Should there be any components missing from the engine, their replacement will, of course, involve an extra charge.

Since the reconditioned units always have new liners, pistons and rings, there are no major deviations from the standard dimensions of a new engine. New main and big-end bearings are always incorporated and the crankshafts are reground.

The advantages of the scheme to an operator are as follows. The vehicle can be back in service with the minimum of delay. Considerable saving can be made with regard to capital investment and storage space for spare parts. The operator avoids having to invest capital in specialized machinery and equipment, which will be operated at a low utilization rate, and to employ skilled labour on this class of work. It is not necessary to carry spare engines in stock to replace those that are being overhauled. Since the reconditioning is done by the factory, it automatically involves the incorporation of many of the latest improvements in respect of design. Finally, the operator's overhead costs will not be expanded in the housing and maintenance of plant not continuously in use.

Corrosion of Aluminium Alloys

Bimetallic Corrosion and Preventive Measures in Road Transport Vehicles

G. FitzGerald-Lee, F.R.Econ.S., M.I.E.I.

In moist or wet conditions, the corrosion of a metal may be accelerated, of course, by direct contact with another metal, and this is known as bimetallic, galvanic or electrolytic corrosion. The two metals and the liquid together constitute a cell, causing a small electric current to flow and leading to the corrosion of the baser of the two metals. Several factors affect the amount of corrosion caused: the nature of the two metals and their surface films, their relative electrode potential, their relative areas, the conductivity of the liquid and the resistance of the electrical circuit as a whole.

Bimetallic corrosion can have serious effects when one of the metals involved is comparatively base and the other comparatively noble—the baser the metal the more inherently corrosive it is—such as aluminium and copper. Stainless steel and aluminium usually provide an exception to the rule, owing to the combined resistance of their two protecting films impeding current flow and thereby reducing galvanic action.

Corrosion is also encouraged when the area of the nobler metal is many times that of the baser—for example, when a copper sheet is fastened with aluminium rivets. Aluminium tends to be attacked when it is moist and in contact with metals such as copper or nickel or their alloys, because it is a baser metal than either; it is less affected by moist contact with tin, but the attack can be serious with lead or iron in certain conditions. When aluminium is in contact with magnesium or zinc, these metals, being baser than aluminium, tend to suffer attack and to provide sacrificial or cathodic protection for the aluminium.

In bimetallic corrosion, the amount of metal dissolved from the anode varies directly with the quantity of electricity, that is, the current × time that it passes. The current however, depends both on the difference of potential between anode and cathode and on the total resistance of the entire electrical circuit in accordance with Ohm's Law, that is, the combined resistance of the metals themselves, the resistance at their surfaces in contact with the electrolyte and the resistance of the electrolyte. The accompanying Table shows the solution potentials of some metals and alloys with respect to a standard calomel electrode, and it provides an initial guide to the possible effects of bimetallic corrosion. Other factors also have considerable bearing. Chiefly they are: the resistance of the electrolyte and the nature of the stable surface film on the metal; the concentration of the electrolyte, which affects its electrical resistance; the nature of the ions present in the electrolyte; polarization effects; relative areas of anode and cathode; the physical nature of the corrosion product, and temperature variations. Each of these factors can influence the total resistance of the circuit.

The corrosive nature of environments in coastal districts is partly due to the low electrical resistance of salt solution. Similarly the bad effects of industrial atmospheres on metals arise largely from the sulphur compounds, sulphurous and sulphuric acids, which are formed as a result of burning coal and which dissolve in the moisture in the air, in the rain as it falls, or in films of condensed water on the metal. On the other hand, in rural areas rainwater remains relatively pure and corrosion is much less marked, although all other conditions remain the same. Chloride and sulphate ions are the most damaging in their effect on aluminium alloys.

Any detailed discussion of the ions present in the electrolyte or of polarization is beyond the scope of this article. The significance of surface films is demonstrated by stainless steel. Though of much higher solution potential than aluminium, stainless steel seldom causes attack because its oxide film offers a high total electrical resistance to the flow of current and so prevents corrosion. The oxide film on aluminium sometimes acts similarly in regard to bimetallic corrosion.

The effect of the relative areas of the anode and cathode can be expressed in general by saying that, for a given area of anode, the attack increases in severity the greater the area of the adjacent cathode. For example, aluminium is invariably anodic to copper: under identical conditions it would therefore be even more unwise to use aluminium rivets in a copper sheet than copper rivets in an aluminium sheet—although in both cases the rivets would be likely to fall out in time and thus neither combination is recommended.

When used internally, aluminium does not suffer attack in contact with steel. When there is good electrolyte, however, such as the condensed moisture in industrial areas, external parts may suffer local attack. The extent of the attack depends, of course, on the severity of the conditions and to some extent also on the particular alloy of aluminium used. Road transport vehicles in southern or eastern England would suffer far less from this type of corrosion than in Lancashire, Glamorgan or London, where grime, coal-dust and so on, retains moisture and causes trouble when lodged between dissimilar metals.

Several surface treatments are of course available for application to steel, to minimize corrosion at junctions with

Table: SOLUTION POTENTIALS OF SOME METALS AND ALLOYS

	Metal	Negative Potential Volts
BASE ↑	Magnesium	1·73
	D.T.D.118 (Mg-Mn)	1·67
	Galvanized iron	1·14
	Zinc	1·05
	Aluminium Zinc	1·0
	Cadmium-plated steel	0·86
	N4 (Al-Mg)	0·85
	Aluminium	0·85
	D.T.D.363 (Al-Zn-Mg-Cu)	0·84
	LM6 (Al-Si)	0·83
	N3 (Al-Mn)	0·83
	LM7 (Al-Si-Cu-Ni-Fe)	0·81
	H12 (Al-Cu-Mg-Ni-Si-Fe)	0·78
	BSS353, mild steel	0·78
	Grey cast iron	0·78
	Hot-dipped tinned steel	0·74
	H14 (Al-Cu-Mg-Mn)	0·68
	Chromium plate on nickel on steel	0·61
	Tin electroplated on steel	0·55
	Lead	0·55
NOBLE ↓	Tin	0·5
	Stainless steels	0·13—0·43
	Brass 60/40	0·33
	Aluminium Brass	0·29
	Cupro-nickel	0·26
	Brass 70/30	0·25
	Copper	0·22
	Aluminium Bronze	0·15
	Nickel	0·14
	Tin Bronze	0·08

aluminium: they include sherardizing, calorizing and tin-zinc plating, all three of which are particularly suitable for threaded components such as nuts and bolts. The hot-dip aluminizing of steel is a recent and useful development.

Spraying steel with aluminium over the area near the point of contact, by either the powder or the wire process, is considered to give the best protection. Not only does it prevent the occurrence of bimetallic attack on the aluminium component but it also protects the steel from rusting. Sprayed zinc coatings can also be used, but aluminium coatings give better protection, thickness for thickness, and are often more economical. Aluminium coatings are also preferred because the attack of zinc is accelerated by contact with aluminium.

When steel components are to be used in contact with aluminium, they may with advantage be galvanized, but then their surfaces are more difficult to paint than are sprayed surfaces. Zinc being generally anodic to aluminium, corrosion is to be expected at the zinc but not at the aluminium surface in contact with it. After a period however, depending on the conditions and the weight of the zinc coating, failure may be expected, and if the aluminium is left in direct contact with the steel, bimetallic attack may follow at the expense of the aluminium. Zinc coating may also be applied by the sherardizing process of heating the steel in powdered zinc, and aluminium is sometimes applied by calorizing.

Where hot-dip galvanizing is impracticable, as on fine screw threads, the steel may be zinc- or cadmium-plated. Cadmium is itself resistant to corrosion and may act sacrificially, though to a lesser degree than zinc. The plating must be done properly and an adequate thickness of the metal deposited; even then the life of cadmium plate on steel is sometimes rather short under exposed conditions. The general requirements for zinc and cadmium plating on steel should conform to BSS 1706:1951, which lays down minimum coating thicknesses; "A" quality is the most suitable for use in conjuction with aluminium components.

Tin-zinc, 80 per cent Sn 20 per cent Zn, can be satisfactorily deposited on small steel components for general requirements in use with aluminium. Substantial coatings of cadmium are best in marine atmospheres, and of zinc in industrial conditions. Only when metal spraying is impracticable, paints that are richly pigmented with zinc and which give an adherent and electrically conducting coating may be applied to both the steel and the aluminium or to the steel alone, the metal-loaded paint acting to some extent as a sacrificial anode. When this method is used to prevent bimetallic corrosion, it is essential that the zinc-rich paint should be applied direct to the bright steel and not over a primer.

Local attack on aluminium may be increased when the component is coupled with cast or wrought iron in a corrosive environment; the precautions already enumerated, for carbon steels, are also appropriate in these applications. The behaviour of aluminium and alloy steel couples depends largely on the passivity of the steel; thus it is generally safe to couple aluminium with 18/8 chromium-nickel stainless steels. Stainless steels are being used to an increasing extent for bolts or screws in conjunction with aluminium, and where their use is economical they are to be preferred. Stainless steel fittings may be attached to aluminium windows—in fact, the two metals offer a very good combination for a variety of uses.

Magnesium and its alloys are anodic to aluminium, but an attack on the aluminium is possible because corrosion products of magnesium are liable to be markedly alkaline and also because the high potential difference between magnesium and aluminium is liable to produce appreciable alkalinity at the cathode, that is, the aluminium side of the bimetallic couple. When aluminium is coupled with zinc or zinc base diecasting alloys, special precautions are unnecessary, but the zinc usually suffers some preferential attack. Articles plated with nickel followed by chromium, in accordance with the requirements of BSS 1224:1953, may be used in conjunction with aluminium in moderate conditions.

Aluminium can be attacked by contact with nickel and its alloys. Under mild conditions, nickel-plated steel screws have been successfully used in the assembly of aluminium, but in this connection, also, reference should be made to the minimum plating requirements of BSS 1224. There have been cases of Monel metal screws and rivets causing attack, but only in severe conditions. Tin-plated or tin-coated articles can normally be used safely in contact with aluminium. A good, non-porous coating of tin is required to prevent the underlying metal from becoming exposed, and this is especially important when that metal is an active one in relation to aluminium, as in the cases of copper or steel components.

In many industrial atmospheres, there is no interaction between lead and aluminium, for example, pressure- or gravity-diecast aluminium cleats are used inland on lead-sheathed cables with no protection. However, in marine and certain industrial atmospheres precautions are necessary at lead-aluminium junctions: these precautions include the insulation of the two metals or the complete exclusion of moisture by coating the joint all over.

Contact between aluminium and copper or its alloys—brass, bronze, aluminium bronze—tends to cause corrosion, and should therefore be avoided. This action is more severe than with steel-aluminium couples, and only thorough insulation can be relied on to prevent accelerated attack on the aluminium under all conditions. Under mild conditions only, nickel-chromium plating in sufficiently thick coatings or cadmium plating can be applied to the copper, or the surfaces may be well tinned. Full insulation should be inserted between aluminium and titanium if used externally on vehicles.

Faying surfaces of all metals can hold moisture by surface tension, and therefore should be coated, before assembly, with a suitable jointing compound; alternatively, if the crevice is small, at least a thick primer should be used. Wet assembly, with these jointing materials, also effectively fills crevices and seals the faying surfaces. Compounds of this type are also used to prevent bimetallic corrosion under moderate conditions.

The jointing compounds used with aluminium are pastes, generally loaded with barium chromate or zinc chromate. Chromates are powerful inhibitors of corrosion, and pigmented moisture-excluding compounds are beneficial in this way and are also suitable with regard to their viscosity. Some of the many proprietary brands on the market are hard-setting, while others remain tacky and flexible for long periods.

In many cases it is more effective, as well as more convenient, to apply the chromated paste as a loaded tape, which can be unrolled and cut off as required. Such tape should be non-rotting and applied in such a way—for example, by sealing it in—that the inhibitor cannot be washed out to leave a strip of material liable to give poultice effect.

Hot bitumen, several coats of bituminous paint or at least two coats of leafing aluminium paint are suitable for some purposes, especially for providing a waterproof barrier. The surface should, of course, be preheated to ensure adhesion of the paint. White lead or red lead are generally unsuitable for use with aluminium, and in marine and industrial atmospheres they are actually harmful.

In order to avoid bimetallic corrosion, the dissimilar metals can be insulated from one another by non-absorbent inserts. Separators of this kind are often fitted when aluminium components are joined by bolts or studs of other metals:

they must necessarily be non-absorbent, close-fitting and tight. It is important to ensure that the moisture cannot form a conducting bridge across the exposed edge of the insulation: to this end, the insulating material can usually be extended beyond the edges of bolts and nuts. Rivets or bolts at dissimilar metal junctions can be insulated along the shank as well as under heads and points. The materials used include plastics, rubber and Neoprene.

All-aluminium construction is advisable in corrosive conditions as it eliminates bimetallic corrosion and other undesirable effects such as deterioration of appearance as a result of the rusting of steel bolts. It can nearly always be achieved, not only for low-stressed applications such as welded tanks and containers, but also for large structures and assemblies subject to considerable stress. These can be assembled with large aluminium alloy rivets, instead of steel rivets and bolts, and modern welding techniques enable structural shapes to be welded on site. High strength copper-containing alloys can be used for components in exposed positions, provided that the strong alloy is protected against corrosion by cladding or metal spraying. Mixing different aluminium alloys in one structure rarely causes any trouble. The author is indebted to the Aluminium Development Association for information on which this article is based.

Reproduction of Drawings

A SEMI-AUTOMATIC photoprinting machine, known as the Zephyr, has been introduced by the NIG Manufacturing Co. Ltd., 3 to 9, Dane Street, London, W.C.1. The outstanding feature of the machine is that a wind tunnel is employed to blow the gaseous ammonia developer over the print. This arrangement allows much more rapid developing than does the normal convection layout of a perforated plate above an ammonia tank. It is possible to obtain satisfactory prints, from drawings up to 42 in wide, at a developing speed of 40 ft/min, although so high a speed is rarely required.

The machine embodies five electric motors: one of $\frac{1}{2}$ h.p. for driving the feed of the printing and developing sections, one of $\frac{1}{3}$ h.p. for the cooling equipment, two of $\frac{1}{10}$ h.p. each for the cyclone fans, and another of that size for the ammonia pump. Either rolls or cut sheets of sensitized paper are fed by hand into the machine: in roll form, the paper is carried beneath the glass feed table, and is severed as required by a wire of cheese-cutter type. The printing section of the machine is of orthodox design, embodying a 3 kW quartz lamp tube within a glass cylinder of 6 in diameter, which has a ground surface to ensure accuracy of shape.

After exposure, the paper is ejected from the printing section and is then fed by hand into the developing section, which runs at a synchronized speed. To avoid corrosion, stainless steel is employed for the narrow wind tunnel through which the paper passes while being subjected to the ammonia vapour. This vapour is blown along the tunnel by the two cyclone fans from the tank at one end of the machine. To minimize fumes and wastage, the ducting forms a closed circuit: ammonia consumption is said to be considerably lower than in the normal type of developer.

This view of the NIG Zephyr photoprinting machine shows the neat design. The maximum speed is 40 ft/min and prints 42 in wide can be produced

Among the interesting technical details of the Zephyr are the use of ball bearings on all working shafts; a self-priming diaphragm type ammonia pump with Perspex body and visible level gauge; a direct-reading speed control dial; efficient filtration of the cooling air; and print delivery to either the front or the rear of the machine. With rear delivery, a second operator can be employed to trim and stack the prints. As a precaution against damage through oblique feeding of the paper roll, a foot operated tension release for the feed is embodied: pressure on the long pedal permits the paper to be straightened.

The machine is well styled and has an attractive blue and beige stove-enamelled finish. Particular attention has been paid to ease of maintenance, to which purpose the back panel is readily detachable for access to the motors, speed control, drives and fans. The end doors are hinged at their rear edges; with them open, the lamp can quickly be removed for replacement, or for cleaning of the interior of the glass cylinder. The lamp itself is mounted on a rigid holder to minimize the risk of accidental damage. It is possible to clean the exterior of the cylinder without removing it from the machine. Behind the left-hand end door is stored the ammonia bottle, adjacent to the pump; the tubing is of the transparent, plastics type.

A valuable feature of the Zephyr is its compactness. The overall dimensions are $62 \times 34\frac{1}{2} \times 51$ in, and it weighs approximately 11 cwt. Its capabilities were effectively demonstrated at its official introduction recently, when prints were produced in seven seconds. The first production batch of machines was at that time already in hand at one of the company's London factories.

Another NIG product of interest to large engineering organizations is a translucent, sensitized plastics material on which prints of master tracings can be made, to form additional masters. These can be distributed as required to branch offices or sub-contractors, and normal paper prints can be obtained from them with the same clarity as from the tracings. Use of this material can save a lot of additional tracing work and has the further advantage that, though the image will not smudge in handling, it can readily be rubbed out should any modifications be necessary; these can be made directly on to the sheet in pencil or ink. The material is untearable and does not discolour nor shrink in storage. It does, however, require a slower developing speed than does the normal type of sensitized photoprinting paper.

On the left is the Sole, and below, the Luce. Both are by Bertone and are based on the Alfa Romeo 2000 chassis, the wheelbase of which has been increased by about 10 in relative to that of the standard version. A noteworthy feature of the Sole is the harmony of the lines of the rear wing opening with those of the direction indicator and motif, together on the scuttle side

Continental Coachwork

A Review of Recent Trends and Some Interesting Details

RECENTLY, practically all the Continental coachbuilders have been concentrating on obtaining the pleasing styles characteristic of their custom built coachwork without resort to elaborate chromium plated adornment or fussy detail. The vertical, or traditional, style of radiator grille has almost completely disappeared, the sole survivors of this type, among those exhibited at the recent Geneva Show, were the Graber models based on the Alvis chassis. Although Alfa Romeo still insist on coachbuilders retaining the trefoil form of radiator grille, the vertical central portion is now in almost every instance so small that is does not conflict with the horizontal lines of the side leaves of the design. Most of the coachbuilders have adopted the horizontal form of grille with a rectangular outline, but modified lines are distinguishable in this type of grille employed by Beutler on the D.K.W. chassis and to a lesser extent by Pinin Farina on the Fiat 1500 model.

In many instances, the radiator grille surround, or front skirt panel, is extended forwards to increase the overall length of the vehicle and thus to give it a well streamlined appearance. In general, serious attempts have been made to ensure that front and rear end treatments harmonize: where the horizontal features are accentuated at the front end, for example, by the formation of a line pressed horizontally above the radiator grille, a similar type of rear end treatment has usually been adopted; and on models in which the rectangular type of radiator grille is employed, rectangular features are also incorporated at the rear end, and so on.

Few of the coachbuilders have produced any bodies incorporating twin headlamp arrangements, but an interesting example of this layout is the Lancia Gran Tourismo model by Touring of Milan. With regard to side lamps, a new feature that has been introduced to harmonize with the protruding rectangular grille arrangement is the forward extension of the rectangular housings for the direction indicator lamps, as adopted by Vignale.

So far as side elevation is concerned, the aim in design is, of course, at increasing the apparent overall length of the vehicle and reducing the height. This is effected either by means of horizontal lines in the pressings or by the judicious use of chromium plated strip. This latter applied decoration is not used extensively by the Continental coachbuilders, as it is by some American body designers. Where the pressed lines form a tapered band, with the small end at the front and increasing in width towards the rear they are called *lancéolé* motifs, a term that is derived from their resemblance to the lances formerly carried by knights on horse-back. Other devices adopted are the forward extension of the housings for the headlamps and the rearward extension of those for the tail lamps. More attention, perhaps, might be paid to the finishing of wheels: it has been said that wheels are to a motor car as shoes are to a lady. The American car manufacturers, of course, go to extremes with regard to styling of this feature.

Almost all the cars have wrap-round front and rear windows, and considerable pains are taken to reduce to a

minimum the thickness of windscreen pillars. In practically every instance the rear quarter lights are hinged at their forward vertical edges, and have a toggle clip attachment at the rear: in other words, they are in the form of pivoted ventilating panels. There is much to be said in favour of this arrangement: it is inexpensive and simple, there are no problems of control and of accommodating a winder, nor is there any difficulty with regard to housing the glass when the window is open, as there is with a wind-down layout. Lastly, draught-free ventilation is obtained.

There is a noticeable trend towards increased area of glass all round. This increase has been effected in the last year or so partly by employing shallower roof pressings than have been prevalent hitherto. In general, the rear end of the roof pressing is either overhung slightly over the rear window or else is streamlined to blend with the profile of the window.

Interior trimming arrangements are perhaps not quite so well executed as they have been in previous years. For example, in many instances more pains could have been taken to ensure that the door presents a harmonious picture both when open and when closed and viewed in conjunction with the general theme of the decor of the interior.

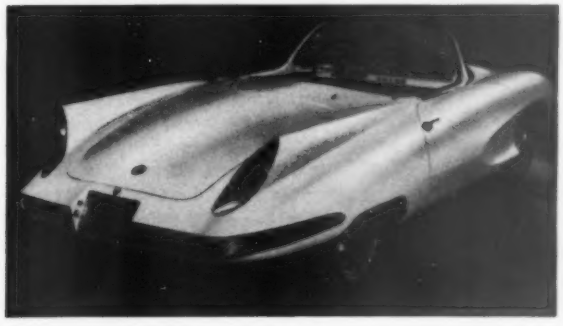
Several sports cars have been exhibited without bumpers either at the front or rear. An important feature with regard to the styling of this type of vehicle appears to be obtaining a genuine streamlined form. The arrangement of windscreens on this type of vehicle has received careful attention, and a noteworthy example is that of the Bertone Fiat 1500, which is discussed in detail later. From the point of view of windscreen wiping, the layout of the Bertone Alfa Romeo, shown in an accompanying illustration, is noteworthy, since the curvature of the screen is such that the wipers can reach almost to the pillars on each side.

There is a tendency to simplify dash facia treatment, noteworthy examples being those of the Ghia body on the Fiat 1200 chassis and the Bertone Alfa Romeo. Leathercloth type material is used almost exclusively for head linings, and in many instances it is perforated for sound absorption, and backed by foamed plastics material, glass fibre or felt stuck to the roof panel. Rubber floor covering is used most widely, but there are still a few more expensive makes of car that have carpet. Some have underfelt and others have foamed plastics material under the rubber or carpet.

Bertone

Among the bodies that have been produced by Bertone is one on the Giulietta Sprint Special chassis. The main features of the design can be seen from the illustration; the front end has a steeply falling bonnet line with the traditional Alfa Romeo trefoil grille layout, but the arrangement is different from any of the others in that the vertical portion,

Deeply recessed tail lamps and a fully streamlined bumper are the outstanding features of the rear end of the Bertone Fiat 600 car



In the Bertone Sole, the grab rail on the right of the facia is swept up over the instrument panel and down to the scuttle side, on the left

An overhanging canopy is a feature of the rear end of the Bertone Luce

forming the centre of the trefoil, is simply housed in a single elongated opening, which it divides in two to form the side portions of the three leaf design. Horizontal features are accentuated by a chromium plated bar extending from each side of the central portion to the outer extremities of the side openings.

An unusual fitting is a transparent deflector to prevent flies from striking the windscreen. This deflector is fitted to the scuttle, between its front edge and the rear edge of the bonnet lid. Air outlet louvres are incorporated in the lid, but they are arranged each side of the transparent deflector, presumably so that they are not in an area of high air pressure.

The door handle also is unusual. It comprises a simple push button, immediately behind which is a recess in the door shut pillar, so that, to open the door, it is necessary simply to push the button and insert the fingers into the recess and pull on the trailing edge of the door. Both the windscreen and the rear light are very steeply sloping, to give an unusually good streamlined shape. There is no front bumper; at the rear, however, there is a form of bumper on each quarter panel, but since it is apparently of polished aluminium, it is there mainly for decorative purposes and does not afford much protection.

Perhaps one of the most interesting features is the windscreen. It is of the wrap-round type, but the radius of curvature is relatively large so that the centre portion of the screen is much farther forward than is usually the case. The advantage of this arrangement is that the windscreen wipers can be used to wipe almost the whole of the wrap-round portion. Thus one of the major problems of a

The length of the Sole has been accentuated by the extension of the front wings to house the headlamps and of the rear wings to house the tail lamps. The unusual arrangement of the ends of the rear bumper and the horizontal line above it on each side also help in this same respect

An exceptionally comfortable rear seat arrangement has been adopted on the Sole, and an ashtray, with a spring-action lid, is mounted on top of the propeller shaft tunnel

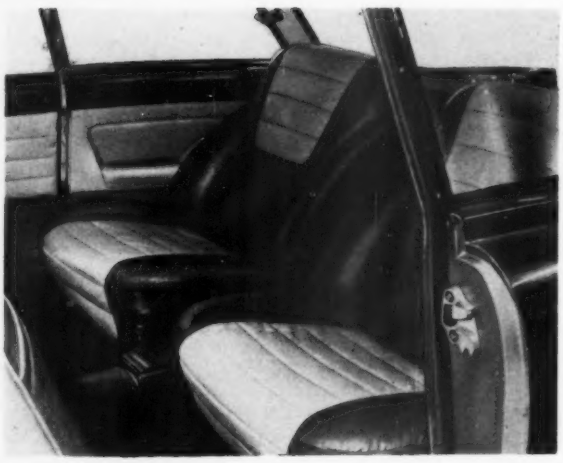
wrap-round screen has been solved in an extremely simple manner.

Bertone have also produced two bodies on the Alfa Romeo 2000 chassis. One is a Gran Tourismo model designed to seat four people in comfort, while the other is more of a family saloon, which will seat four people in even greater luxury; in fact, the family saloon, or limousine model as it is called, will even seat six people but, naturally, not so comfortably. For both models, the wheel-base has been increased by about 10 in, relative to that of the standard chassis. It is this feature that has enabled so much room to be provided inside both cars.

The general style of the Gran Tourismo body can be seen from the illustration. On the scuttle side panel, the flashing direction indicator is combined with a motif and has been designed to harmonize with the line that sweeps up and over the rear wheel openings to the extreme end of the vehicle. The signal of the direction indicator is, of course, repeated by the other lamps at the extreme front and rear ends of the vehicle.

Inside the vehicle, the dash facia design is neat. A grab rail extends horizontally from the right-hand side to the instrument panel, over which it sweeps and then down on the left to join the dash side. On each cant rail above the rear of the door opening, a handle is fitted so that passengers in the rear seats can get out more easily. Between the rear seats, which like the front ones are of the bucket type, is an ashtray mounted on the propeller shaft tunnel. The head lining is of perforated leathercloth backed by a sound absorbent material stuck on to the roof panel, which is an unusually shallow pressing.

In this model, bench type seats are used at the front and



the rear. There is a centre armrest on both. The front seat squab is divided, and the armrest is mounted on the right-hand, that is, the passenger's portion. The Gran Tourismo is named the 2000 Sole after the new Autostrada in Italy, and the other one is called the Luce, which means light, because of the exceptionally large windows that it has.

Since it has not been necessary to make the limousine of such streamlined form as the Gran Tourismo version there is more head room in the back, but in both models there is plenty of knee room for passengers in the rear seats. Both the front and rear bumpers of the limousine model are

Among the interesting features of the Beutler DKW are the generously upholstered front seats, with their adjustable squabs, and the integration of the rear seat armrests with the wheel arches. The head lining is perforated and appears to be backed by a foamed plastics material, stuck on the underside of the roof panel

In general, Bertone favour the elliptical theme in their styling, as is exemplified by this model on the DKW chassis. However, in this instance, it has been modified to give a more modern rear wing treatment than would be possible with truly elliptical lines

recessed into the panels, to which they are secured rigidly. This arrangement is exceptionally neat and is easy to clean, but it has the disadvantage that the panels are more easily damaged than if the bumper is clear of the panels. On the wheels there are rimbellishers and the standard Alfa Romeo nave plates, which are dished chromium plated discs with transparent plastics centres and are of unusually pleasing design; metal is deposited on the inner face of the transparent plastics, to form the well-known Alfa Romeo badge.

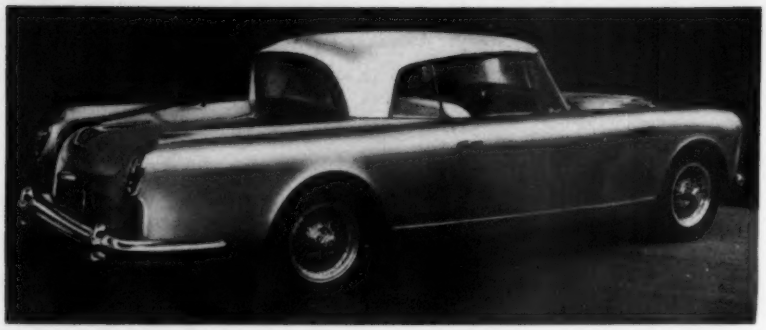
As is common practice with Continental sports cars, bumpers have virtually been dispensed with and a particularly well streamlined shape has been adopted on the Bertone Alfa Romeo Giulietta Sprint Special. Noteworthy features are the unusual arrangement of the Alfa Romeo grille, and the layout of the windscreen and wipers

Another Bertone model is a sports car designed on the Fiat 1500 chassis. Like that based on the Alfa Romeo Giulietta Sprint Special, it has no front bumper, but it has a rear bumper, which forms a continuation of the streamlined trailing edge of the panelling at that end. There are flared fins, one on each side at the back, and the direction indicator lamp and rear lamp, together with a reflector, are accommodated in deep recesses formed in the trailing end of each fin. The side panels behind the front wheels are flared to give a better air flow past the brake drums. A chromium plated capping is fitted externally on the upper edge of each door and extensions of it sweep up on each side over the head rail in a rather neat arrangement. Curved sidelights, of Vitrex glass, are employed on each door. They are well guided and wind down with a pleasantly smooth and easy action. Curved glass is, of course, much more satisfactory for this purpose than transparent plastics sheet.

Perhaps the most interesting feature of this vehicle is its wheels, which are manufactured by Carlo Borrani, S.P.A., of Milan. They comprise aluminium rims with steel discs, the two being riveted together. The rims are of extruded section, rolled round and flash butt-welded together. In this way, a saving in weight of 4·4 lb per wheel has been effected. This is not only advantageous from the point of view of the reduction of unsprung weight, but it also facilitates wheel balance. Since the yield strength of the aluminium used is approximately the same as that normally used for steel rims, it is claimed that there should be no difficulty with regard to denting of the rims when the tyres are removed with tyre levers, for replacement or repair of either their cases or the inner tubes, if there are any.

Beutler

Beutler have produced an extremely attractive four-seat sports touring car on the Auto Union 1,000 cm³ chassis. The overall length of the vehicle is 12 cm greater than that of the standard model. For many years Beutler have favoured the elliptical basis for their styling rather than the more rectangular and angular features widely adopted by



The rear-raked back light arrangement has been adopted on this Graber Alvis drophead coupé model. It has the advantage that the glass can be retracted easily and stowed neatly before the canopy is folded

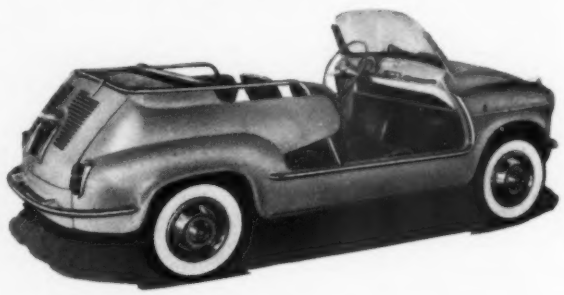
the other coachbuilders, and especially by American car designers. Although in overall conception, this car is of elliptical style, it is of interest to note that the radiator grille is almost rectangular, being of similar shape to that of the Pinin Farina Fiat 1500, except in that it is the opposite way up. A considerable degree of curvature has been introduced into the lower edge of the grille. Horizontal features are accentuated by a chromium plated strip along the top edge of the grille opening, a horizontal bar across the centre of the grille and by the bumper below. A relatively large air intake is incorporated on the bonnet lid and its front opening is of a shape that harmonizes with the grille treatment. The bonnet line falls sharply and the panelling is extended forward to overhang the grille.

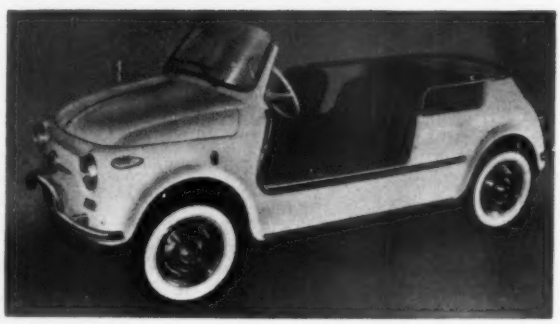
As can be seen from the illustration, the plainness of each side is broken up by two horizontal chromium plated strips. One is at the level of the sill and extends between the two wheel openings, while the other is placed forward of this and approximately in line with the centre of the headlamp. This arrangement tends to accentuate the horizontal features of the side more neatly than if longer strips were employed.

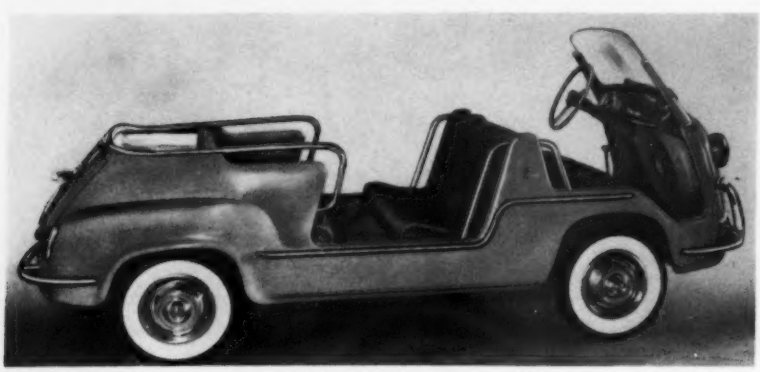
Ghia of Turin

Ghia of Turin have produced a range of vehicles on the Fiat Multipla, the 600 and the 500 models. It would appear that they are used in holiday resorts for taking people from hotels down to the beach and on other short journeys. As can be seen from the illustrations, the seats are of wickerwork and therefore are not very comfortable, so they would be unsuitable for long tours but they are ideal for carrying people wearing wet bathing costumes. Obviously, the aim has been at keeping the cost to a minimum. On the Multipla model, the floor covering is of rough hessian, which of course, is a non-slip material and warm, therefore again suitable for bathers. The others have rubber floor coverings.

These vehicles have been designed for moving along narrow streets in the small Continental towns. Each has a rubbing rail along both sides. This rail is of tubular form, like the bumpers, and is chromium plated, and, presumably, its function is to protect the body sides against damage as the vehicle passes close to the walls or carts at the sides of crowded narrow streets. On all three vehicles there is no headrail over the windscreen, and an awning is supplied for use as a sunshade. The forward end of the awning is



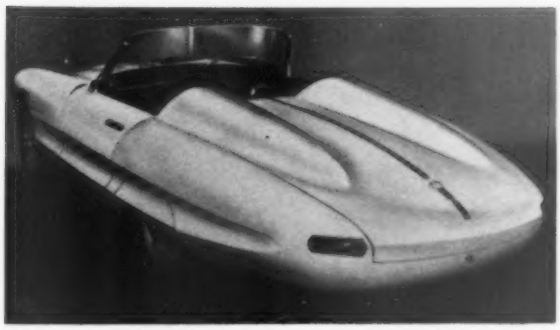




This group of three illustrations shows the three beach-car models made by Ghia of Turin. The upper one is based on the Fiat 600, below it is the Fiat 500 and on the left is the Multipla; all three are skilfully designed to keep costs low

The absence of the conventional Alfa Romeo radiator grille is an unusual feature of the Pinin Farina model on the 3·5-litre chassis. Obviously the prime criterion has been efficient streamlining and ducting

Of the two illustrations below, the upper one shows the rear end of the Pinin Farina Alfa Romeo. The lower one is of the dash facia on the Alfa Romeo model with a body by Ghia of Turin; an interesting feature of this facia is the concave arrangement of the instrument panel, to avoid reflections on the sides of the wrap-round screen at night



located by two pegs, one on the top of each windscreen pillar, and the rear end is carried on two vertical pillars that fit into simple sockets, mounted one each side of the rear seat.

Graber

This coachbuilder, who for many years has been producing exceptionally fine bodies on Alvis and other chassis, this year has produced a convertible type of vehicle body of unusual form. It is a drophead coupé, the head of which can be manually folded into the tonneau. Its unusual feature is that a rearward sloping glass is fitted in the back light, instead of the forward sloping type more commonly employed. The advantages of this arrangement are as follows. A simple roof pressing can be employed; it is easy to fit the head lining; the employment of a flat glass minimizes cost; and, because the roof overhangs the glass, there is less likelihood of rain obscuring the rearward vision. The rear quarter panels are more or less parallel to the sides of the vehicle and, therefore, offer a minimum of obstruction to the rearward vision. At night, glare from the headlamps of following cars is reduced because of the slope of the glass, and during the daytime, the overhung canopy protects the interior trim from the adverse effects of direct sunlight. In this particular application, the glass can be raised or lowered by means of an electric mechanism controlled by two buttons on the propeller shaft tunnel, underneath the armrest for the front seats. One button is used to raise and the other to lower the glass.

Other features of the vehicle are not unlike those of earlier models and also of the other more conventional models produced this year. At the front end, an unusually wide air intake opening is incorporated on the bonnet lid. At the rear, small fins of fine section are extended up from the wings, and are swept slightly outwards. Inside the vehicle, considerable attention has been devoted to the incorporation of devices to facilitate control. For example, the ventilating panels at the front of the door lights, which are of rectangular rather than triangular form, are opened and closed by means of a wheel type of control. The rear quarter lights can also be raised or lowered, and their handles, which are of the conventional type, are recessed to rotate in large diameter circular dishings in the vertical face of the trim on each side of the seats. Another interesting feature at the rear end of this vehicle is the relatively shallow-drawn section of the wrap-round portions of the rear bumpers. This not only looks neat, but also has an advantage in that it is less likely to be caught on, for instance, the doorpost of a garage as the vehicle is taken in or out.

Pinin Farina

Over many years Pinin Farina has built up a very high reputation as a motor car stylist. This reputation has been based on vehicle designs that are noteworthy for their simplicity and lightness. In fact, the aim in these designs has been at not incorporating any lines that do not serve a positively useful purpose. Moreover, all the lines and detail features are so arranged as to harmonize with the overall conception. Lightness of appearance is obtained partly by appropriate balancing of the relative proportions of the various side, end and roof panels, and partly by the use of pressed lines and chromium plated strip. Skilful design of contours to make the best possible use of highlights is another important feature. Where chromium plated adornment is used, it is invariably light in section.

There are a number of interesting features on the body based on the Alfa Romeo 3·5-litre chassis. One of these is the absence of a radiator grille. In fact, a ducted air intake is employed, the opening being in the overhung portion of the front skirt panel. This feature gives an exceptionally clean and streamlined appearance to the front end of the vehicle. There is no bumper, and the headlamps are set

A noteworthy feature of the Superloggera coupé, on the Lancia Flaminia chassis, is the neat arrangement of the four headlamps

The Vignale Lusso model is based on the Lancia Appia chassis. An unusual detail is the forward projection of the housings for the direction indicator lamps, to harmonize with the grille arrangement

back from the skirt panel. An air intake duct, with a painted line along its crown, is incorporated in the boot lid to break up the otherwise plain appearance of that part of the body, and to clear the highest parts of the engine installation. This duct also helps in the avoidance of excessive under-bonnet temperatures. There are outlet louvres on each side of it, just in front of the scuttle. Two more outlet vents, one at the rear end of each front wing panel on each side of the scuttle, help to provide for adequate flow of air past the wheels and brakes. The bonnet lid is not hinged, but instead can be lifted off completely. It is secured by two conventional catches, one on each side, adjacent to the scuttle; and there are two fixed pegs at the front end, which project forwards into location slots.

As can be seen from the accompanying illustration, the body sides are broken up by a broad channel section pressed in the panels from the rear edge of the front wheel opening to the back end of the vehicle. In addition, a perforated chromium plated garnish plate covers the sill, and extends the full length between the wheel openings. This was introduced primarily to conceal the exhaust, on one side, but it has the additional effect of reducing the depth of the side panels, and also covers that portion of the body panelling which otherwise would become dirty with mud splashed up from the wheels. However, in view of the incorporation of rectangular perforations, which are approximately $\frac{7}{8}$ in long by $\frac{1}{4}$ in wide, it would appear that this panel is rather susceptible to damage when the car pulls up close to a high kerb. The rear end of the body is of streamlined form, with the lamps accommodated behind moulded covers that conform with the profile.

Inside the vehicle, both the black dash facia panel and the panel underneath it are well padded to avoid damage to the occupants in the event of an accident. The seat squabs are high and give good support to the shoulders. An unusual feature of the arrangement is that there is no glove box in the dash facia; instead it is between the two seat squabs.

The door construction is unusual. Although the trim panels are deeply recessed in the door framing, to give extra elbow room, they are not stuck to the outer panel as is generally the practice with this type of construction. Instead, they are secured by screws to the flanges of the framing. The door handles are of the type designed several years ago by Pinin Farina, and used on a number of their models. They are flush fitting, and there is a push button by means of which they are released, to spring out from their housings; after they have been released in this way, they can be pulled out to open the door, and if let go sharply, they spring back and lock in their housings again. To obtain the maximum possible amount of room in the boot, there are two petrol tanks instead of one, and they are fitted, one on each side, immediately behind the rear wheel arches.

Pinin Farina also make a very handsome coupé on the Fiat 1500 chassis. From the accompanying illustration it can be seen that the sides of the radiator grille are inclined outwards; the profile of each side of the body, as viewed from the front, also slopes in the same manner; and the head and direction indicator lamps are arranged with their centres on similarly inclined lines to harmonize with this theme. On the bumper, between the direction indicator lamps and the sides of the grille, are large, upstanding over-riders. The top end of each over-rider is connected to the body structure, the attachment pieces passing through rubber grommets in holes in the front panel. A very low bonnet line has been obtained by incorporating in the lid a streamlined blister, to clear the carburettor air intake. The blister is asymmetrically arranged, on the left-hand side of the lid. Needless to say, this arrangement was carefully considered before it was finally passed as perfectly satisfactory so far as appearance is concerned.

The sides are broken up by a line extending from the headlamps almost to the end of the vehicle. In one version of the body, this line is emphasized by a chromium plated finisher strip extending from the front to a point just behind the centre of the door. It is of interest to compare the two illustrations, one of the vehicle with and the other without

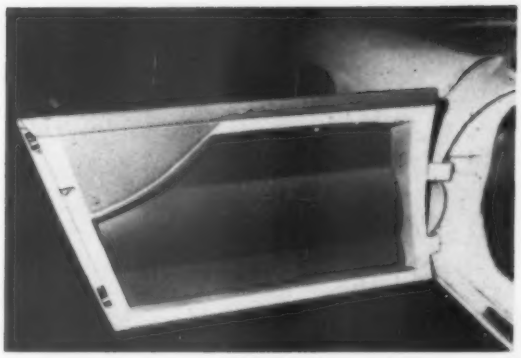
this strip. Another chromium plated strip is fitted along the top of the sill, and it extends between the two wheel arches. Small fins are incorporated at the rear end; Pinin Farina does not seem to favour the exaggerated fins used on the American cars.

An interesting feature of the trim is that hide and leathercloth are employed together. The hide is used for the surround portions of the seat trim and leathercloth for the pleated centre portions. The two are perfectly matched for colour: it has been found possible to obtain perfect matching with black, red, tan and green. Most of the other trim panels are covered with leathercloth, and a similar type of material is used for the head lining. A polished veneer facia panel is employed with a matt black painted top panel and a black padded under portion.

All the windows have chromium plated finishers on the exterior framing. The drip channel, on the other hand, which extends along the head rail and each cant rail down to the waist-line at the rear, is painted cream, which is the same colour as the lower portion of the body. On the model exhibited at Geneva this year, the roof panel was red. An exceptionally deep rear light is employed; in fact, it is 23 in deep. It is moulded to conform with the streamlined rear portion of the canopy.

Among the larger models produced by Pinin Farina this year is a body on the Ferrari 3½-litre chassis. No attempt has been made to break up the surface of the bonnet by means of air intake ducts or any other device but, despite this, the area does not look too plain. This is because the falling bonnet line leaves the wings standing fairly high on each side. A horizontal rectangular grille treatment has been adopted. This seems to be one of the easiest and best to use in conjunction with the falling bonnet line. The bumper over-riders have rubber inserts to prevent damage as a result of slight shocks. Similar inserts are employed on the rear over-riders.

It is of interest to note that, since there is not any marked ornamentation on the bonnet lid, a chromium plated air intake grille has been incorporated on the scuttle, for the air supply to the heater. As on most of the Pinin Farina models, a barely perceptible line is pressed along each wing crown to accentuate the highlights. The Pinin Farina Ferrari can be distinguished from the standard model by virtue of the



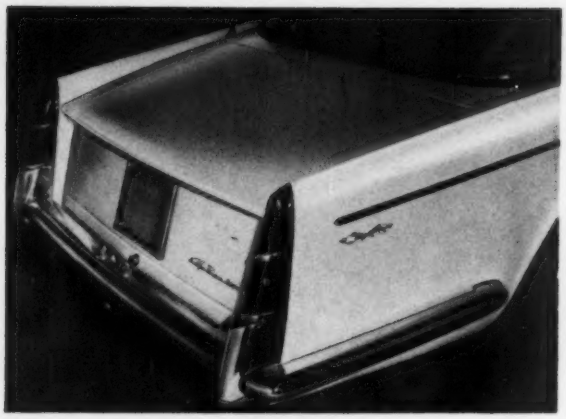
On the Pinin Farina Alfa Romeo, the door trim is not stuck to the outer panel, but instead is secured to flanges on the framing

lancéolé lines pressed in the sides and extending from the top of the front wheel arch to the rear wheel arch, and also by the chromium plated ornamentation between the front wheel arch and the door pillar.

From the point of view of styling technique, an interesting feature of the side of this vehicle is the flow and harmony of the lines that bound the rear quarter light and the door pillar and the wheel arch. The cant rail sweeps down to join the pillar between the rear light and the rear quarter

Above: Rear end of the Pinin Farina Fiat 1500, which has an exceptionally large and well streamlined rear light. As on most of the Pinin Farina models, the fins are small and their crown lines fall slightly

It is of interest to compare these two views of the Pinin Farina 1500, the bodies of which are identical except for the chromium plated strip extending back from the headlamps on the model on the right



Rear end of the Vignale Alfa Romeo, showing the angular relationship between the bumper, its over-riders, tail lamps, fins and the boot lid

light, and this line is continued by the rear of the wheel arch. A similar sweeping, almost spiral, line has been adopted for the door shut pillar.

Inside the vehicle, an elaborate floor covering is employed. On each toeboard there is a rubber mat. Beneath this, and extending over the whole of the floor on each side, is a quilted covering, with a leathercloth facing, and this is laid on a foamed plastics underfelt. The head lining also is of leathercloth, and this, too, is backed by a foam plastics sheet stuck securely to the lower face of the steel roof panel.

Touring

The coachbuilders Touring, of Milan, have produced an exceptionally pleasing sports hardtop coupé on the Lancia Flaminia chassis powered by the 2,458 cm³ engine. A noteworthy feature of this model is the arrangement of the four headlamps at the front. As always, the problem has been to reduce so far as possible the width of the crown of the front wing. The two headlamps at each side are mounted on a separate panel, which is inserted into the front end of the wing. On each side, the leading edge of the flank of the wing panel, where it extends backwards from this insert, is very close to the outer lamp bezel. The wing panel is swept up to a clearly defined crown line extending back, from a point approximately above the centre of the outer lamp, to merge with the waist-line. Inboard of the crown line, the panel slopes fairly sharply down over the inboard lamp and then drops steeply to the bonnet surround. Direction indicator lamps of rectangular form are mounted under each pair of headlamps, and the bumper over-riders, which are more ornamental than functional, are also of a similar rectangular shape.

Vignale

Among the several models that Vignale produce is a body on the Lancia Appia chassis. This vehicle, which is called the Lusso, is a good example of harmonious styling. At the front end, the skirt panel protrudes forward to house the rectangular radiator grille, but at no point is it further forward than the leading edge of the bumper. The rectangular, direction indicator lamps below the headlamps, are also in forward protruding housings.

To match the air intake duct on the centre of the bonnet lid, a similar shape is pressed in the boot lid and extends back to the handle. On each side of the vehicle, the apparent height of the panels is reduced by means of three horizontal parallel lines. One is the waist-line, which is carried forwards along the wing crowns to the front headlamp and rearwards to the rear lamp; the second is a broad painted line just below the door handles and extending almost from the front to the rear of the vehicle; and the third is a chromium plated strip on the top of the door sill. The

Perhaps one of the most interesting aspects of Continental coachwork in the post war period is the wide variety of designs that have been produced incorporating the traditional Alfa Romeo grille. On this Vignale body, horizontally divided direction indicator and side lamp installations and unusually wide over-riders are incorporated

This body, by Vignale, is based on the Triumph TR3 chassis. Like that on the Lancia Appia, it has prominent rectangular housings for the direction indicator lamps, and a forward projecting radiator duct

The illustrations above and on the left are of the Vignale Fiat 600. The engine compartment, at the rear, is well ventilated, and simple tubular bumpers are employed

Right: A lancéolé line is pressed in each side of the body panelling of the Pinin Farina Ferrari Special. This model can be distinguished from the standard version by the large motif on the scuttle side panel

Below: An unusual feature of the rear end of the Pinin Farina Ferrari is the mounting of the pair of rectangular lamps adjacent to the bumper over-riders. The horizontal line pressed in the rear skirt panel is swept up at each side to flow into the vertical line of the rear lamp installation

upper edge of the painted line below the door handle is clearly defined by a chromium plated strip.

Vignale have also achieved a considerable degree of harmony in the styling of their body based on the Alfa Romeo 2000 chassis. Two dummy air intake ducts are employed on the bonnet lid. As can be seen from the illustration, a distinct horizontal line is pressed in the panel immediately above the radiator grille, and a similar treatment has been adopted for the rear end, where a clearly defined horizontal line is formed by an overhung portion of the boot lid. In general, the front end styling represents a very successful adaptation of the traditional Alfa Romeo trefoil type radiator grille to modern requirements. The horizontal features are accentuated not only by the line pressed above the grille, but also by two horizontal chromium plated bars in each of the side leaves of the trefoil, in line with the centres of the horizontally divided auxiliary lamps, which are directly beneath the headlamps. The third horizontal feature is of course the bumper, which has unusually wide over-riders.

A horizontal chromium plated strip fitted along the top of the door sill extends almost to the wheel openings. Above this is another strip extending almost the full length of the vehicle, in line with the door handle. A direction indicator is incorporated at the front end of this strip. By virtue of the blending of the door handle and indicator lamp into this one straight line, a neat appearance has been obtained.

Since the price of custom built bodies is inevitably high, many of the Italian coachbuilders use the smaller, less expensive chassis as the basis of their designs. In this way, a car that has special appeal to those who like something different can be produced at a price that is acceptable to customers in large enough numbers to justify manufacture. A favourite chassis, of course, is the Fiat 600; one such model built by Vignale is called the Fiat 600 Special. The price of this model is 1,100,000 lire. It has neat external boot and bonnet lid hinges, and the chromium plated front and rear bumpers, which protect only the quarters, are of simple tubular construction.

The arrangements for ventilating the engine compartment are unusual. The rear skirt panel is formed mainly by a simple, flat, perforated sheet, which is chromium plated, like the grille normally used at the front of a car. There is an air intake duct in the centre of the lid, and the sides of the boot lid are swept up, as can be seen from the accompanying illustration, to give additional ventilation.

A feature of particular interest is the floor covering. Over the whole of the floor, the interior faces of the sills and the wheel arches is fitted a moulded black rubber mat. On each toeboard and over the propeller shaft tunnel, a second rubber mat is fitted on top of the first. This second mat has a pattern embossed on it, the high portions of the embossing are black and the depressed areas between them are red. The head lining is of a plastics material, probably p.v.c., and

is perforated for sound absorption. A thick sheet of felt or foamed plastics is stuck to the roof panel.

A simple dash facia arrangement has been adopted, the whole of the panel being painted black. There are two small panels inserted in the facia, one in the centre to carry the electric switches and warning lamps, and the other is the instrument panel and is immediately above the steering column. This latter piece contains three instruments: a speedometer, flanked on one side by the water temperature indicator and on the other by the petrol gauge. All these instruments are large and can be easily read.

Another Vignale model is the Triumph Italia. This is a sports coupé of exceptionally attractive appearance, based on the Triumph TR3 chassis. As can be seen from the illustration, there is a forward extended radiator duct at the front end. In harmony with this are the forward extended housings for the direction indicator lamps and the number plate mounting on the bumper. All these features are of rectangular form. A sharply falling bonnet line has been adopted and, as on the Pinin Farina model, there is a blister asymmetrically positioned on the boot lid to clear the carburettor air intake.

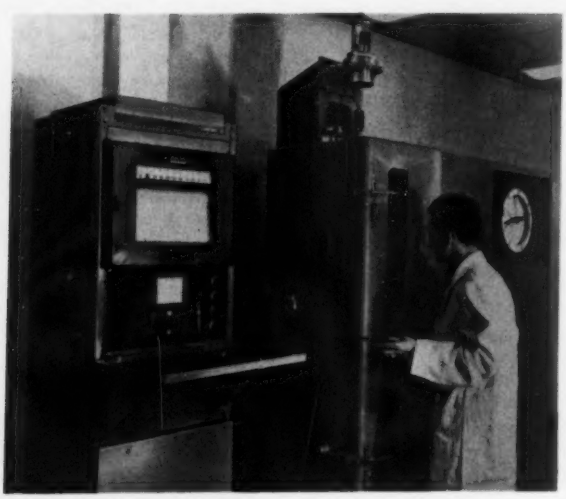
As viewed in side elevation, the vehicle displays a considerable simplicity of line. The only chromium plated adornment is a strip mounted along the top edge of the sill: this strip extends between the two wheel arches. Wire wheels are employed and the front wheel arches are of open design to allow free flow of air over the brake drums.

Research on Elastomers

A NEW elastomers research laboratory was opened recently at Hemel Hempstead by the Du Pont Co. (United Kingdom) Ltd., a subsidiary of E. I. Du Pont de Nemours and Co. Inc., of Wilmington, Delaware, U.S.A. This venture forms the first completed stage of the Du Pont company's European programme, other sections of which are the Neoprene factory now under construction at Londonderry, Northern Ireland, the paint and acrylic fibre plants to be built respectively in Belgium and Holland, and the sales co-ordinating organization being formed in Geneva. The purpose of the research laboratory is two-fold: to develop, by means of a technical assistance service, improved end products using Neoprene, Hypalon and Viton elastomers, and to evolve better methods of compounding these elastomers.

As is now well known, the synthetic rubbers, or elastomers, offer advantages over natural rubbers for many engineering applications. These advantages include a high resistance to abrasion, sunlight and weather, petroleum-base and other oils, also to oxygen, ozone and various chemicals. The materials can function efficiently at higher temperatures than can natural rubbers and can be compounded to retain their flexibility equally well at the other end of the temperature scale. In consequence of these properties, elastomers are finding increasing favour in the automobile industry for such items as jointing washers, sealing rings, hoses of various sorts, tyre side walls and door sealing strip.

The electronically controlled testing machine at the du Pont laboratory is used to investigate the strength and elastic modulus of elastomers



The research laboratory, which has a floor area of 10,000 ft^2, is divided into three main sections: dry processing, fluid processing and physical testing. In the first section, solid compounds are investigated with the aid of equipment that includes a variety of vulcanising units. One of these is primarily for the continuous extrusion coating of wire and cable, but it can also be used for the production of hose for automobile applications.

In the fluid processing area, work is done on fluid elastomers such as those based on latex or dissolved rubber. For the rapid preparation of the materials, an ultrasonic homogenizer and a high-speed ball mill are used. This apparatus is of the type used by latex goods fabricators, manufacturers of paints and coatings, and by the foam rubber industry.

The physical testing section is extremely well equipped for its function. There is a very accurate, electronically controlled load measuring machine, which can be used to measure the elastic modulus, tear resistance, tensile strength and adhesion of samples. It can operate at any predetermined temperature between −70 and +550 deg F. Another machine, known as a weatherometer, can simulate the desired conditions of sunshine, humidity and even heavy rain, to accelerate the accumulation of data on weathering characteristics. A salt spray cabinet is used to determine the suitability of materials for marine purposes. Other properties that can be investigated are those of electrical insulation, and of resistance to high and low temperatures, ozone exposure, abrasion and fatigue.

British Standard

A NEW British Standard has been introduced to cover the accuracy of serrated circular cutters for gear shaving. It is B.S. 2007:1959 and caters for the production of crowned and uncrowned gears of external or internal type, for the automobile industry, turbine reduction units and general engineering work. The 11-page specification is broader in its scope than the previous edition, published in 1953, which deals primarily with cutters for shaving marine reduction gears. Alterations have been made where necessary to the tolerances and requirements for cutter bores and spindle diameters, to bring them in line with current needs. Copies of B.S. 2007:1959 can be obtained from the Sales Branch of the British Standards Institution, 2, Park Street, London, W.1. The price is 4s, and postage will be charged extra to non-subscribers to the British Standards Institution.

Recent Publications

Brief Reviews of Current Technical Books

The Autocar Road Tests, Spring 1959

London: ILIFFE AND SONS LTD., Dorset House, Stamford Street, S.E.1. 1959. $11\frac{3}{8} \times 8\frac{3}{8}$. 80 pp. Price 6s.

Under the recently altered arrangements, this publication is now issued twice a year. The Spring edition is of particular interest and value to everyone considering buying a new car, since it gives them the latest information on new models at the start of the buying season. Motor dealers and others in the industry will also find it a valuable aid in their work.

This new edition presents road test reports and full performance data of twenty-one cars, fourteen of which are British, three German, three Italian and one French; they include small family cars, luxury saloons and sporting models for enthusiasts. Each report contains a description of the car's behaviour under varying conditions, and has been compiled after some hundreds of miles' running in the hands of experts. Also included are comments on the construction and design, detailed plans showing the controls, instruments and seating arrangements, reproductions from numerous photographs, and a comprehensive table of technical information. A table summarizing the performance figures for all the cars featured in the book is also given, thus enabling the key figures extracted from each road test to be compared easily.

The volume is presented in an attractive, varnished, three-colour cover and handsomely printed in photogravure, providing a permanent record of this season's cars. It contains reports on the following cars: A.C. Ace; Austin A.40; Austin A.95 Countryman; Berkeley 492 cm³ Sports; B.M.W. 600; Borgward Isabella; Citroën ID 19; Daimler Majestic; Fiat Abarth Zagato; Fiat 1200 Gran Luce; Frisky Coupé; Gazelle Convertible; Hillman Minx Convertible; Humber Super Snipe; Jaguar Mark IX; Lancia Flaminia; Mercedes 220S; Morris Minor Traveller; Morris Oxford Traveller; Austin Princess IV; Standard Vanguard Automatic.

Trader Handbook 1959: A Legal, Technical and Buying Guide for the Motor, Motor Cycle and Cycle Trades

London: TRADER PUBLISHING CO. LTD., Dorset House, Stamford Street, S.E.1. 1959. $8\frac{1}{2} \times 5\frac{1}{4}$. 716 pp. Price 17s. 6d.

This book provides essential information for manufacturers, trade suppliers and repairers of motor, motor cycle and cycle goods. By virtue of a practical and comprehensive treatment of every aspect of these industries, it supplies accurate and useful answers to the daily problems of buying, selling and servicing throughout the year. It will also prove of great value to firms overseas seeking contact with British Suppliers.

There are seven sections, divided by guide cards with thumb indexes for easy reference. Preceding these sections is a Legal Guide covering motor, motor cycle and cycle affairs, with information on points of law that experience has shown to be most troublesome to traders. In the Technical and General Section (Cars and Commercial Vehicles) can be found lists of vehicle manufacturers, with vehicle specification details, car and goods vehicle servicing data, front end service data, and oil producers' S.A.E. numbers. This section also includes lists of suppliers of spare parts and repairers, trade associations, wage rates, an index of vehicle registration numbers and addresses of licensing authorities.

The Technical and General Section (Motor Cycles and Cycles) contains two new features: they are Motor Cycle Cable Data, giving clutch, throttle and brake cable sizes with types of nipples; and Motor Cycle Lamp Bulbs, giving types of bulbs fitted to head, pilot, rear and stop lamps. Also in this section are the names of three-wheeler, motor cycle, scooter, moped and pedal cycle manufacturers; other features are vehicle and auxiliary engine specification details, cycle repair charges, hub and brake lining dimensions, spare parts suppliers and repairers, associations, articles on the setting up of a cycle workshop, the fitting and maintenance of sidecars, magneto maintenance and the latest wage rates of the motor cycle and the cycle trades. Wholesalers of motor, motor cycle, and cycle goods are given for the first time in a separate section which contains both alphabetical and territorial lists.

Under the heading Transport Service Equipment is an up-to-date list of firms who specialize in the manufacture or sole distribution of garage and work-shop equipment for manufacturers and repairers. Manufacturers and sole distributors of motor, motor cycle, and cycle accessories and components are listed in the Buyers' Guide, while approximately 5,000 proprietary names attached to such goods are identified in a separate section.

The Trade Addresses Section has been revised and lists all manufacturers, concessionaires, distributors and wholesalers mentioned in the Handbook, giving their postal and telegraphic addresses, telephone numbers and, where possible, the name of the firms' sales and service managers. These revisions, together with the carefully selected technical information and other practical data, make the work an invaluable time-saving reference book for every retailer and business man in the industry.

Its main sections are as follows: Technical and general (cars and commercial vehicles); Technical and general (motor cycles and cycles); Wholesalers; Transport service equipment; Buyers' guide; Proprietary names; Trade addresses.

British Instruments

London: SCIENTIFIC INSTRUMENT MANUFACTURERS' ASSOCIATION OF GREAT BRITAIN AND UNITED SCIENCE PRESS LTD., Boswell House, 9, Gough Square, Fleet Street, E.C.4. 1959. $11 \times 8\frac{1}{4}$. 322 pp. Price 42s.

British Instruments is a directory and buyers' guide. It covers scientific and industrial instrumentation for research and production in a wide range of applications. These applications include measurement and control of temperature, pressure, humidity, flow, weight, texture and dimensions; inspection and gauge testing, both manual and automatic; data processing and computers; optics, ophthalmics, navigation, meteorology, microscopy, astronomy, surveying and levelling; physics, mechanics, pneumatics, hydraulics and electrics; analysis; laboratory ware; atomics, electronics and nucleonics.

The ten chief sections in the directory are as follows. Associations allied to the instrument industry; British Standards Specifications; Consultants, engineers and installers of instrumentation schemes; Manufacturers of prototypes and small batches; Instruments and components, with their manufacturers; Glossary in French, German, Spanish and English; Addresses of manufacturers and their overseas agents; Selected trade names; Manufacturers announcements; Advertisements.

Principles of Transistor Circuits: Introduction to the Design of Amplifiers, Receivers and other Circuits

By S. W. Amos, B.Sc. (Hons.), A.M.I.E.E.

London: ILIFFE AND SONS LTD., Dorset House, Stamford Street, S.E.1. 1959. $8\frac{1}{4} \times 5\frac{1}{2}$. 167 pp. Price 21s.

The development of the transistor is generally regarded by electrical engineers as one of the most notable landmarks of post-war years. Because of its small size, robust nature, low power consumption and small heat dissipation, the transistor has not only replaced the valve in many of its conventional applications, but has also opened up new fields in electronics. Applications include miniature radio receivers, and audio frequency equipment, including hearing aids, transmitters and sinusoidal operators, switching, data handling equipment and computers, instrumentation, and including photo devices, and control circuits, among which are those for guided missiles, rectification and power supplies.

This volume has been specially written by a member of the Engineering Training Department of the BBC, to assist those who require an introduction to the design of transistorized

equipment, and it is intended for professional designers, students and amateur constructors. Assuming no previous knowledge of the subject, it devotes the first two chapters to explaining the physical processes occurring in transistors; but subsequently the main emphasis is on the application of these principles to the practical problems of design, and most of the book is concerned with the determination of quantities such as input resistance, stage gain, optimum load, power output, values of coupling capacitors and transformer winding inductances.

A large number of worked examples is included and the mathematics of these is confined to simple algebraic manipulation. The examples show the order of the practical magnitude of the various quantities. Although the design of amplifiers and receivers is given the greatest prominence, some details are also included of photo-sensitive devices, transistor relaxation oscillators, and the newer types of transistors which may extend the frequency range over which semi-conducting devices can operate satisfactorily.

The contents of the book are as follows: Semi-conduction and junction diodes; Common-base amplifiers; Common-emitter amplifiers; Common-collector amplifiers; Bias stabilization; Small-signal amplifiers; Large-signal amplifiers; Transistor superheterodyne receivers; Other applications of transistors and other types of transistors; Index.

Metal Industry Handbook and Directory 1959

London: ILIFFE AND SONS LTD., Dorset House, Stamford Street, S.E.1. 1959. $8\frac{1}{4} \times 6$. 586 pp. Price 21s.

It is widely recognized that this book is a standard work of reference, offering a comprehensive source of information to all those engaged in, or connected with, the non-ferrous metal industries. Up-to-date information on the properties of the newer as well as more familiar metals is given, and an extensive section devoted to summaries of British Standard Aircraft Material, D.T.D., and Admiralty specifications has again been included.

A very wide range of producers, stockists and factors of all basic metal products, metal working machinery and tools, and metal finishing equipment is listed in the Directory for Buyers. The Handbook also includes a section on the chief metal finishing processes and data regarding all the common rod, bar, sheet and strip products. All who manufacture, use or deal in non-ferrous metals will require this up-to-date information, which is conveniently presented in one annual volume. The work is now in its 48th year of publication.

The contents of Section 1, entitled General Properties of Metals and Alloys, are as follows: Properties of the metals; Particulars of the metals; Contraction of castings; Expansion of alloys; Specific resistances of alloys; Aluminium and aluminium alloys; Copper and its alloys; Magnesium alloys; Nickel alloys; Typical tin analyses; Mechanical properties of zinc die-casting alloys; Tempering metals; Soft solders; Fusible alloys; Silver brazing alloys; Fluxes for brazing; White metal bearing alloys; Soft silver solders; Fluxes for soft solders; Hard solders for aluminium; Proprietary alloys; British Standard Specifications; D.T.D. specifications (non-ferrous); Admiralty Specifications (non-ferrous); Standard classifications for non-ferrous scrap metals.

Section II comprises General Data and Tables, and the contents of Section III, Electroplating and Allied Processes, are as follows: Polishing; Plant for electroplating; Degreasing and cleaning; Some plating processes; Metal colouring and phosphating; Commonly plated metals; Plating solutions; Density conversion tables; Rate of deposition of nickel; Rate of deposition of copper from copper cyanide solution; Rate of deposition of chromium; Rate of deposition of zinc from acid and cyanide zinc solutions; Rate of deposition of silver; Speeds for polishing wheels; Chemical and electro-chemical constants of metals; Common and chemical names and formulae of substances used in the plating trades.

Section IV is a Directory. It contains: Trade names; Metal and allied trade associations and societies; Scientific and technical institutions; Directory of buyers; List of addresses; Index to advertisements.

Kempe's Engineers Year-Book

London: MORGAN BROTHERS (PUBLISHERS) LTD., 28, Essex Street, Strand, W.C.2. 1959. $7\frac{1}{2} \times 5$. 1,416 pp. Price 82s. 6d.

Three sections of this well-known work have been revised and re-written. They are those on flow metering and mechanical testing, refrigeration, and paints and varnishes. Apart from these, the whole of the subject matter has been carefully examined and a great many alterations and additions have been made to bring the information up-to-date. Among the chapters in which additional matter is incorporated is that headed "Standard dimensions," in which are given details of locknuts, lock washers, torque spanners, fastening treads, machine screws, machine screw nuts, pipe threads for the petroleum industry, unified threads and acme threads. More information on broaching machines is given in the section headed "Machine tools," and electric furnaces are dealt with in the section on "Iron and steel". Conveyor belt cleaners are discussed under the heading "Mechanical handling". The section on "Road vehicles" now includes details of automatic and semi-automatic transmissions, voltage regulator circuits, and permitted gross laden weights. As an example of the endeavours of the publishers to produce a truly comprehensive work, it is of interest to note that the chapter on "Mechanics" now includes fundamental formulae of the motion of missiles and satellites, and of escape velocity.

British Plastics Year Book 1959: A Classified Guide to the Plastics Industry

London: ILIFFE AND SONS LTD., Dorset House, Stamford Street, S.E.1. 29th Edition, 1959. $9\frac{1}{4} \times 6\frac{1}{4}$. 644 pp. Price 42s.

This edition has been thoroughly revised and divided into nine sections. Three are devoted to classified lists of manufacturers and suppliers of materials, finished products and equipment, while a fourth section contains the world's largest list of trade and proprietary names connected with the industry; it covers materials as well as finished goods. Each trade name is followed by a definition of the product and the manufacturer concerned.

The names and addresses section, containing nearly 4,500 firms associated with plastics, is now divided into two: one is for the United Kingdom and the other for overseas. In the Who's Who section are lists of names and positions of prominent people actively engaged in the industry in Great Britain. The set of tables giving comparative properties of plastics materials, which was included for the first time in the previous edition, has now been revised and brought up-to-date. In the same section is included a revised glossary of technical terms, a list of new companies registered during 1958, and specifications relating to plastics.

As a result of a readership survey, it has been decided to discontinue the patent abstracts feature—this information is available through The British Plastics Federation's service—thus enabling the price and size of the Year Book to be kept within reasonable limits. This book remains the only classified guide to the products and manufacturers. The up-to-date information that it provides makes it invaluable to all connected with the plastics industry and to manufacturers and users of machinery and equipment.

The contents of the work are as follows: Glossary of technical terms; Tables of properties of plastics; New companies registered in 1958; Specifications relating to plastics; Guide to plastics material suppliers; Guide to plastics product manufacturers and plastics processors; Guide to equipment suppliers and to services; Directory of trade names; Names and addresses of firms, organizations, consultants, etc. in the United Kingdom; Names and addresses of firms overseas; Who's Who; Technical and general data; General Index.

Automatic Welding

Translated by Major J. H. Dixon

London: BRITISH WELDING RESEARCH ASSOCIATION, Publications Department, 29, Park Crescent, W.1. 1959. $9\frac{1}{4} \times 7\frac{1}{4}$. 94 pp. Annual subscription 10 gns.

The British Welding Research Association has recently undertaken the task of making a cover-to-cover translation of the monthly Russian journal *Avtomaticheskaja Svarka*, which is the organ of the Arc Welding Institute, Kiev, and is published by the Ukranian S.S.R. Academy of Sciences. Although the work under review is the August 1958 issue, it was translated in January 1959. A very wide field of welding practice is covered by the book, many aspects of which are of little or no interest to automobile engineers but, on the other hand, some of the articles are applicable to vehicle and component manufacture. To avoid delays in the translation of the text, all the units are metric but the main conversion factors are given at the beginning of the work.

One of the articles in the issue under review is entitled "A new method of producing ingots and shaped castings, without feeder heads, by adding electro-slag metal". The basis of this method is the addition of metal made molten by the electro-slag process, using consumable electrodes. It improves the quality of the castings and leads to considerable economies in molten metal. Another article is entitled "Local heat treatment of transverse butt welds in tubes, its influence on residual stresses." The stress changes described are those caused by the local heating zones of different widths centred on the weld. In general, the whole issue comprises three sections, the first entitled "Scientific and technical," the second "Industrial section," and the third "News section". Of these, the first covers 83 pages and the other two six pages each.

The Shamrock Car

New 1½-Litre Model with Plastics Bodywork to be Produced in Eire

INTENDED primarily for the American market, a new car having bodywork of glass reinforced polyester resin is to be produced in Co. Kerry, Eire. It is known as the Shamrock, and the manufacturers are Shamrock Motors Ltd., whose present address, while the factory is being equipped for production, is Hunts Farm, Broad Street Green, Guildford, Surrey. The Shamrock is an occasional four-seater, with a detachable hardtop, and its mechanical components are of British manufacture. For example, the B.M.C. 1,489 cm³ Series B engine is fitted, and the gearbox, rear axle, front suspension and brakes are also standard B.M.C. units, to facilitate servicing and replacement.

There are two main reasons for the decision to build the car in the south-west of Ireland. In the first place, shipping charges to the United States are minimized and, secondly, factory rentals are low and labour is relatively cheap and plentiful. The government of Eire has extended remarkable co-operation on the project, even to the extent of arranging for improvement of the local harbour facilities, to enable 10,000 ton cargo ships to be handled. It is expected that production and export should be well under way by the end of 1959. When the initial U.S.A. requirements have been met, the car will, if the demand is sufficient, become available on the British market. An output of 3,000 cars is planned for the first year of production, rising to 10,000 during the following two years.

Although this scale of production is greater than has hitherto been considered economic for reinforced plastics bodywork, the manufacturers have complete confidence in their choice of material. The production by hand of comparable sheet steel bodies in such numbers would present an impossible labour problem, and the tooling costs for pressings are beyond the resources of a small company. Thus, the use of plastics for the body was an obvious choice, particularly in view of the advantages of low weight, freedom from corrosion and the fact that compound curvatures not only can readily be embodied but are advantageous in stiffening the shell.

When the lines of the body were laid out, the necessity for appealing to the American buyer was regarded as one of the main criteria. In consequence, the general shape conforms with current transatlantic fashion, with considerable overhang at front and rear: although the wheelbase is quite modest, at 8 ft 2 in, the overall length is said to be almost as much as that of the latest Ford Thunderbird. Although this length may be rather great for the average suburban garage in this country, it does provide the ample boot space to which the American motorist has become accustomed.

SPECIFICATION

ENGINE: Four cylinders. Bore and stroke, 73·025 mm and 89·0 mm. Swept volume, 1,489 cm³. Compression ratio, 8·3 : 1. Overhead valves, operated by push rods and rockers. Semi-downdraught S.U. carburettor. Maximum b.h.p., 53 at 4,350 r.p.m. Maximum torque, 82·5 lb-ft at 2,100 r.p.m.

TRANSMISSION: Single dry-plate clutch, 8 in diameter, with hydraulic actuation. Four-speed gearbox, with synchromesh on top, third and second. Internal ratios: top, 1 : 1; third, 1·373 : 1; second, 2·215 : 1; first, 3·637 : 1; reverse, 4·755 : 1. One-piece open propeller shaft. Hypoid-bevel live rear axle giving 4·55 : 1 reduction; three-quarter floating half shafts. Road speed per 1,000 r.p.m. in top gear, 15·63 m.p.h.

SUSPENSION: Front, independent, by coil springs and double wishbones; lever type hydraulic dampers. Rear, coil springs and telescopic dampers; axle located by links and Panhard rod.

STEERING: Cam and peg steering box with 15 : 1 ratio. Three-piece track rod with slave lever.

BRAKES: Hydraulic, with two leading shoes at front and leading and trailing shoes at rear. Drum diameter, 9 in. Lining widths, 2½ in at front and 1¾ in at rear. Handbrake operates on rear drums through mechanical linkage.

WHEELS: Steel disc type, 15 in diameter. 5·90—15 in tubeless tyres.

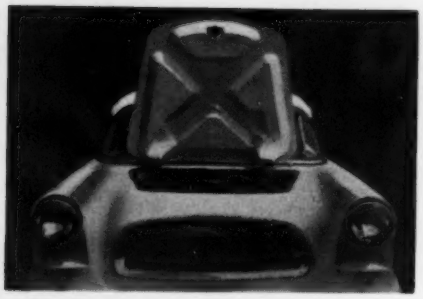
CHASSIS FRAME: Pressed-steel ladder type. Tubular steel sub-frame to carry body.

BODY: Moulded in glass reinforced polyester resin, bolted to sub-frame. Bonnet, doors and boot lid of double-skin construction.

DIMENSIONS: Wheelbase, 8 ft 2 in. Front track, 4 ft 3 in; rear track, 4 ft 1 in. Dry weight, 17 cwt.

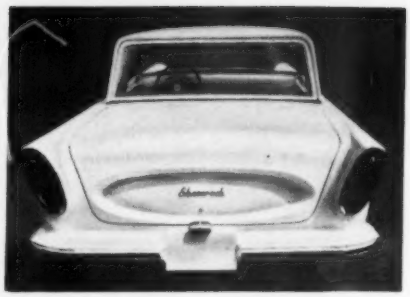
ELECTRICAL EQUIPMENT: 12 volt, with belt-driven generator. 52 amp-hr battery. U.S.A. Westinghouse sealed-beam headlamps. Self-cancelling flashing direction indicators. Twin self-parking windscreen wipers.

The American lines of the Shamrock are apparent in this view. Only one moulding is used for the body shell; the hardtop is built in aluminium and is detachable



Left: As on the doors and boot lid, double-skin construction is used for the bonnet lid. Embossing stiffens the inner skin, which is laid up with the outer skin in the halves of a double mould

Right: This rear view shows the large boot and the inclined rear lamp layout. The bumpers are integral with the body shell and are reinforced by steel tubes



In interesting contrast to the Peerless car, described in the January 1959 issue of *Automobile Engineer*, the body shell of the Shamrock is a single moulding. It is produced by the normal wet lay-up process in a five-piece, split mould comprising the two sides, the front, the facia section and the rear. Flanges, of 2 in width, are employed to attach one mould to another, and the securing bolts are closely spaced. The longitudinal split lines between the moulds are along the top of the wings and tail fins; at the front they run down outside the headlamps, below which there is a hard line that simplifies fettling after separation, and at the rear they follow a similar course round the outside of the rear lamp groups. Because of the reflex curvatures at both ends, the front and rear sections of the mould are withdrawn endwise.

By giving the facia a curvature of relatively small radius use is made of it to stiffen the scuttle area. The bumpers are integral with the shell but are reinforced by partially recessed tubes of heavy-gauge steel, chromium plated, and by additional, internal laminations of glass and resin. Further mouldings form the floor and front wall of the boot. The floor is bonded to the shell to stiffen the rear structure, but the wall sections are bolted in position. Horizontal stowage for the spare wheel is provided on a tray formed in the medial section of the wall.

Because of their relatively flat surfaces, the bonnet, doors and boot lid are of double-skin construction, which has the additional advantage of providing a smooth interior surface. The deep box section of the 36 in wide doors gives them ample rigidity, while stiffness of the bonnet and boot lid is attained by embossing the inner skin. An interesting constructional feature of these components is that the two skins are laid up at the same time in the halves of a hinged double mould. The mould is then closed and the halves clamped together to unite the laminates, which are cured together. This method is considered to be much more satisfactory than the more common one of uniting an uncured moulding with one that has already been cured, as this second system is likely to give rise to distortion. The boot opening extends down almost to bumper level, so that entry is unobstructed.

Constructed in aluminium, the hardtop is secured to the wrap-round windscreen and body by clamps that permit rapid fitting or removal. Sealing is effected by a rubber moulding strip on the upper edge of the screen and by another strip on the lower edge of the hardtop. The rear of the top is slightly undercut, to combine the maximum headroom for the rear-seat passengers with the largest possible boot opening. To save weight, the rear light, which is slightly curved in plan only, is in transparent plastics material.

The body is bolted to a tubular steel superstructure carried on the simple, ladder type chassis frame, which is of pressed steel construction. It would have been practicable, of course, to bond the body in position, but it was felt that, in the event of serious damage, repairs could more readily be carried out if it was detachable. The B.M.C. Series B engine fitted is the single-carburettor version which, with a compression ratio of 8·3 : 1, produces 53 b.h.p. at 4,350 r.p.m. A short, remote lever controls the four-speed B.M.C. gearbox. As already stated, the rear axle is also of B.M.C. manufacture; however, the rear suspension is not by leaf springs but by coil springs, in conjunction with telescopic dampers. Trailing links and a Panhard rod are employed to locate the axle.

For the front suspension, the familiar Austin double-wishbone layout is employed; a feature of it is, of course, the mounting of the upper wishbones on the damper spindles. A cam and peg steering box, with a ratio of 15 : 1, is fitted, and the steering linkage embodies an orthodox three-piece track rod, with a slave lever. The road-wheel diameter is 15 in, and tubeless whitewall tyres of 5·90 in section are standard equipment. As on the current Farina styled B.M.C. 1½-litre cars, the hydraulic brakes have drums of 9 in diameter; the lining width is 2½ in at the front and 1¾ in at the rear. Therefore, the lining area is obviously ample for this vehicle which, fully equipped, has a dry weight of only 17 cwt.

Heating and demisting equipment is included in the standard specification, as are twin windscreen wipers and an interior lamp. This latter component is mounted on one of the door pillars and is operated by a courtesy switch on each door. The upholstery and trim, in plastics-coated materials, are in two colours. On the prototype car illustrated, the facia panel is cellulosed the same colour as the body exterior. Where this colour is a light one, however, the reflection in the steeply raked windscreen is distracting, and it is probable that a matt, dark finish will be used on production models.

Etching Primer

AN IMPROVED etching primer has been introduced by Federated Paints Ltd., of Dobbies Loan, Glasgow. It is known as Strathclyde Etching Primer PA-10 and, unlike most, comprises a single liquid, so that pre-mixing is not required. Application may be by brush, spray or dipping, and air drying takes place within 30 minutes. If still quicker drying is needed for any reason, stoving can be carried out.

The makers state that their etching primer is not a paint but a metal conditioner. It bonds itself, by its etching action, to the surface of ferrous and non-ferrous metals, and is claimed to have more than double the adhesion of conventional metal-priming paints. As evidence of their confidence in this product, Federated Paints are willing to send free samples of PA-10 to firms wishing to test it.

Bright Trim

Increasing Use of Anodized Aluminium Follows Development of "Higher-purity" Alloys and Special Finishing Processes

In its pure state aluminium has a relatively high resistance to corrosion and consequently needs less protection than most of the heavier metals. The so-called commercial metal and its alloys, while resistant, are markedly more sensitive to corrosion, however. Development of high strength light alloys, containing small percentages of heavy metals such as copper, zinc, or nickel, has heightened the need for protective surface treatments. The nature of the heavy-metal additions appreciably influences the strength characteristics and susceptibility to corrosion of the alloy. Corrosion resistance, therefore, becomes a matter of prime importance and the development of satisfactory protective finishes has been, and indeed is still, a major factor. This will be apparent when the subject of anodizing is referred to later.

When considering aluminium for automobile trim it is inadvisable to regard it merely as an alternative to, or a substitute for, chromium-plated steel. Rather, it should be recognized as a metal that, on its own merits, challenges the use of chrome-plated parts. The three main properties of aluminium, on which its application is based, are the low specific gravity of approximately 2·7; the high mechanical strength attained by suitable alloying, heat treatment, and working; and the relatively high corrosion resistance of the pure metal. The characteristic bright polished finish of aluminium is agreeable and, when anodized, is extremely durable. It will retain its lustre for many years, in spite of adverse weather conditions and industrial atmospheres.

It was during the years immediately preceding World War II that "super-purity" aluminium became available in quantities sufficient to justify the development of commercial applications. This metal was a 99·99 per cent purity base aluminium, containing 1·25 per cent magnesium. It was produced under meticulously controlled conditions and was consequently relatively expensive. During the war its use was restricted to reflectors used extensively by the various Services. Increased production within the last twenty years has enabled a variety of other applications to be developed and established. Today, sheet and strip super-purity aluminium are included in the General Engineering Series of specifications. During the past five years super-purity aluminium has been fairly extensively used for a wide variety of purposes, including trim for motor vehicles. Mass producing industries, however, are very price conscious and where bulk supplies are involved cost is a major consideration. The automobile industry, of course, has been extremely keen to obtain a material for trim at a lower cost than was possible with super-purity aluminium.

Manufacturers of aluminium have given serious attention to this demand and, within the last eighteen months, the results of much painstaking development work have been realized. Several manufacturers can now supply, at a substantially reduced cost, sheet material to an acceptable standard, designated "higher-purity" aluminium. This has a 99·7 purity base with up to 1·25 per cent magnesium. With suitable treatment it enables trim manufacturers to reproduce the long-lasting attractive characteristics of super-

Fig. 1. General view of the chemical brightening and anodic treatment shop

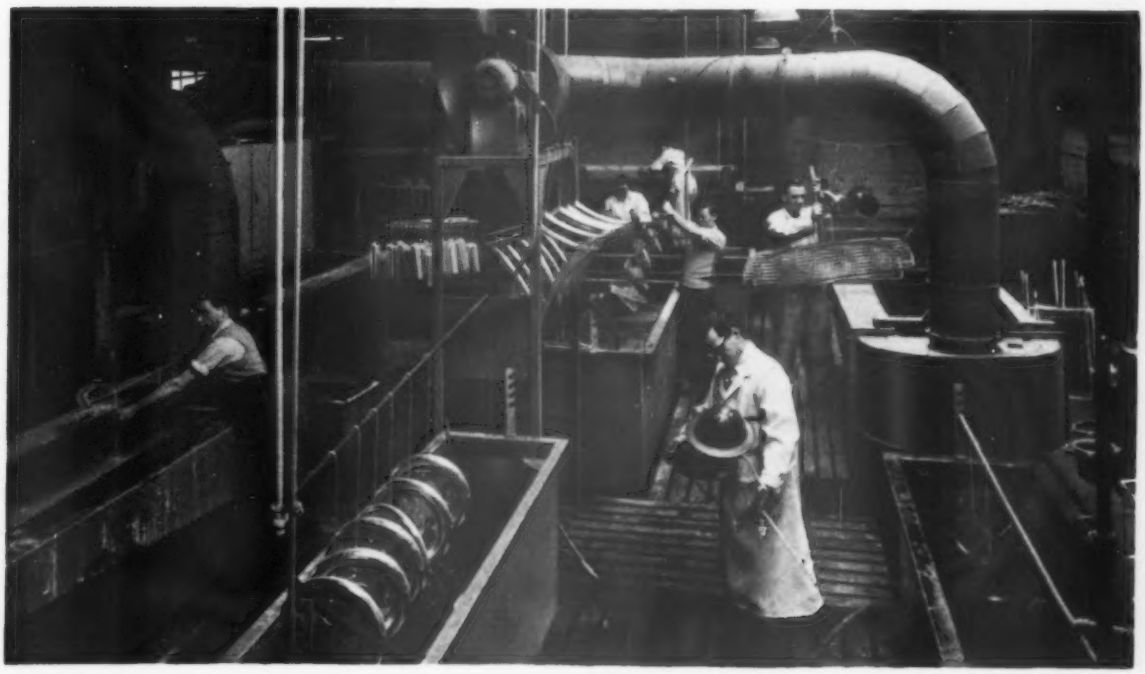


Fig. 2. Careful handling is essential. Here grille pressings are stacked with interleaved paper sheets

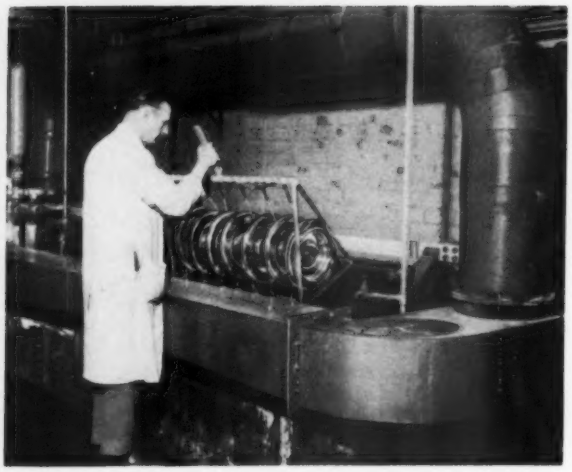


Fig. 3. Chemically brightened nave plates jigged ready for immersion in the anodic treatment tank

purity aluminium at a cost that is competitive with chrome-plated steel, chrome-plated brass, or chromium iron. Higher-purity aluminium is currently being used for various trim components on certain cars and already in greater quantity than is the super-purity grade.

An example of these higher-purity aluminiums is the 330 alloy developed specially for bright trim by Reynolds T.I. Aluminium Ltd. This is based on aluminium of 99·7 per cent purity with an addition of from 0·5 to 1·0 per cent magnesium, and a stringent control of impurities is maintained. It is available in the form of sheet, strip, extrusions, and tubes, in order to cater for all possible trim applications. As regards strength, closely controlled manufacturing techniques enable the metal to be supplied in tempers to suit deep-drawing and pressing operations. These impart to the metal the requisite amount of cold working to produce strength and stiffness in the finished part.

Automobile trim is a decorative application demanding a bright, lustrous and non-tarnishing finish. It is probably desirable that it be not so bright as is required in reflectors. Finishing is of great importance and in this connection a difference in the treatment of the two grades of metal should be noted. Super-purity material suffers no impairment of its brightness or image clarity when given a very high anodic film depth. Higher-purity alloys, however, are rather susceptible to loss of image clarity if the anodic film depth exceeds 8 microns. This is due to impurities present in the material, but as to its durability and service it ranks with super-purity aluminium. The automobile industry, in general, appreciates this characteristic and allows a slighter depth of film to compensate when higher-purity material is used.

Manufacture

Careful handling of the material is necessary at all stages; by the supplier, during transport, and in the factory during fabrication, finishing and packing. All the procedures described, and all the illustrations, relate to the methods employed at the works of the London Aluminium Co. Ltd., Westwood Road, Witton, Birmingham, 6. This company is specially equipped for the production of bright aluminium trim and currently has a large throughput.

It is important that the material, as received, is carefully

Fig. 4. Special jig for supporting radiator grilles during the anodizing process

Fig. 5. Every item is individually inspected for quality of finish before dispatch

cased and interleaved with fine tissue. Before being transferred to the fabrication department, the cut sheets or "blanks" are inspected, particularly for surface imperfections such as rolling marks or grit impregnations. This procedure is essential, as will be noted in the later finishing processes.

Subsequent to this check, the material is formed by suitable methods into the required components. Radiator grilles and wheel nave plates, specific to the automobile industry, are shown in the illustrations. For some considerable period these components have been produced in chrome-plated steel, chrome-plated brass, or chromium iron but within the last two years a substantial changeover to anodized parts has occurred.

The care taken during manufacture is indicated in Fig. 2, showing radiator grilles coming off the piercing press being interleaved with soft brown paper ready for transfer to the degreasing department. After being degreased the grilles are conveyed to the anodic department, Fig. 1, for final treatment.

Brightening

Polished aluminium has a high intrinsic reflectivity which gradually diminishes in course of time, and the relatively soft surface may easily be scratched during cleaning operations. Good protection against such damage can be provided by an anodic film which, being transparent, enables full advantage to be taken of the high reflectivity. There are a number of brightening solutions, of differing composition, with which the reflectivity of the aluminium can be enhanced before the protective anodic film is applied. The chemical brightener in most general use is the phosphoric acid base solution. Another solution, not so well known, has for some years been used by the London Aluminium Co. This is a feature of the Erftwerk chemical polishing process, which was originated in Germany.

Anodizing

Metal to be anodized requires a high degree of cleanliness. If oil or grease is allowed to remain on the surface patchy coatings are obtained, and the brightening solution itself will not operate satisfactorily if contaminated. Generally, the surface of parts to be anodized is cleaned by vapour degreasing or solvent emulsion cleaning and is often given an additional alkaline cleaning treatment. Another important factor is to avoid major blemishes such as deep scratches. These are not removed by mechanical polishing and anodizing processes but are, in fact, accentuated. If superlative results are required, preliminary mechanical polishing must be employed, but heavy polishing should be avoided due to the burning of the metal.

Whether mechanically polished or unpolished, the components are then attached to jigs which may be of singular or multiple type depending upon the size of component. The object of jigging is to make handling as easy as possible without running the risk of deforming the work or of movement of loose points of contact. The jigs or wire employed should preferably be made of aluminium alloy and must be of an adequate section to carry the current when the work is being treated.

After anodizing, the points of contact on jigs are stripped, usually by immersion in a warm, dilute, sodium hydroxide solution and then rinsed in hot water. Alternatively, jigs may be stopped-off with an organic material, such as polyvinyl chloride, and electrical contact made by cutting through the P.V.C. coating at the points of contact. If possible, jigs should be designed to hold the work at equal distances from each other and from the cathode. Contacts must be tight to prevent arcing and film formation between jig and contact. This would increase the resistance and could stop the current altogether, which in turn would prevent an anodic film being formed.

Fig. 6. Above: Percentage checks are made of the depth of the anodic film

Fig. 7. Below: All processing solutions are continually checked to ensure consistent results

In Fig. 3 are shown chemically brightened aluminium nave plates being immersed in the bath prior to anodizing. The handle, or jig contact, held by the operator will in turn be clamped to the contact bar seen running along the top of the tank. This carries the current during the anodic oxidation process. The processing time of anodizing is varied in order to obtain the required depth of anodic film. For the automobile industry the depth ranges from 3 to 12 microns.

Following the anodizing process, the treated parts are carefully rinsed in clear running water before immersing in a tank of boiling distilled water or in a steam generating plant. This treatment is known as sealing, and is necessary since the anodic film is of a porous nature. Until sealed it does not provide a protective or corrosion resistant coating. Hot water or steam causes the film to become hydrated, and to swell. The pores in the film close and seal, and the anodizing process is then said to be completed. The work is next dried, either by de-watering fluids or the application of heat, and in turn un-jigged ready for inspection and laboratory tests.

Advantages of anodized aluminium

There are four definite advantages associated with the use of chemically polished and anodized aluminium in comparison with nickel-chromium plated steel.

Superior corrosion resistance. The corrosion resistance

TABLE I

Surface	Exposure time in weeks			
	0	10	20	40
Super-purity aluminium (anodized)	84	82	82	81
Stainless steel	60	60	60	60
Chromium plate	63	14	7	2
Lacquered silver plate	90	23	14	2
Mechanically polished aluminium (not anodized)	73	14	10	5

of chemically polished and anodized aluminium is higher than that of nickel-chromium finished steel. This applies not only to corrosion of the basic metal, which is a function of the thickness of the nickel deposit, but also to pitting corrosion on the chromium deposit, which cannot be overcome by increasing deposit thickness. Chemically polished and anodized aluminium alloys have proved to have very high corrosion resistance both in out-door exposures and under accelerated tests.

Low processing costs. The cost of mechanical polishing is low due to two main reasons. First, there are comparatively few operations required in a chemical polishing and anodizing process. A typical sequence would require only approximately half the number of operations necessary for the nickel-chromium plate cycle normally used for chrome plating brass, zinc-base alloy, or steel parts. This represents an obvious saving in plant, floor space and labour costs. Secondly, anodizing is the only operation consuming electric current and solution costs in the modern chemical polishing process are relatively low.

Economy in polishing. Depending on the initial state of the surface of the aluminium and on the chemical polishing process employed, mechanical polishing may be either eliminated entirely or else limited to a light emery bobbing, probably using 120-150 grit, and mopping.

Simple control and low rejects. The control of the chemical polishing sequence is simple; the cleaning required before chemical polishing, although important, is less critical than before plating; and various defects which lead to rejection in chrome plating do not arise. It has been estimated that the cost of chemically polished and anodized aluminium alloy motor trim is lower than nickel-chrome plated brass,

Long-term weathering tests, relating to the percentage reflectivity properties of various metals and finishes are given in the accompanying Table I. This shows the effect of exposure in an industrial atmosphere.

In order that the final product is of pleasing and decorative appearance, meticulous care, 100 per cent inspection, and strict control must be applied to the processing of aluminium. Fig. 5 illustrates the individual examination of radiator grilles by inspectors who are conversant with the specifications required by the automobile industry. The importance attached to dirt-free and grease-free work during processing operations will be appreciated. Any grease under the film will be observed in this final inspection and lead to the rejection of the component.

After visual inspection, a percentage of the work is transferred to the laboratory for test purposes. In Fig. 6, nave plates are being subjected to a routine check to ascertain the depth of the anodic film, after which the sealing of the film is tested by a chemical method. All processing solutions are constantly checked, as in Fig. 7, in order to maintain consistent processing results throughout. This laboratory testing is of major importance when dealing with the anodizing of aluminium because the following properties have to be maintained:

TABLE II

Surface	Total reflectivity per cent
Super-purity aluminium (anodized)	84·1
Stainless steel	59·5
Chromium plate	63·0
Lacquered silver plate	89·8

Mechanical properties. The toughness of the anodic film is indicated by the fact that, in some instances, basic metal may be heated above its melting point and still be retained in the oxide film. The mechanical properties of the basic metal are not altered by anodizing

Resistance to abrasion. Anodic films produced by usual anodizing solutions must be of a specific abrasion-resistance figure.

Fig. 8. Wheel nave plate, shown here after the first-stage spinning operation

Fig. 9. Completed nave plate, ready for processing, after final spinning operation

Heat resistance. Anodic film resistance to heat is higher than that of paint, lacquers or enamel. A slight crazing of film may be sufficient to be noticeable when parts are heated. It is caused by the difference in the rates of expansion of the coating and the underlying metal, but this does not appear to affect the protective properties of the film.

A brief total reflectivity chart, obtained by the National Physical Laboratory, is detailed in the preceding Table II. These figures are obtained by using light incident at an angle of 45 deg on flat polished specimens.

Wheel nave plates

In the general external appearance of a motor vehicle the nave plates are likely to exercise an influence as important as the radiator grille. They receive the same careful treatment in processing and even more care in the selection and examination of the material. This becomes necessary as the metal is of relatively heavy gauge, 14-16 s.w.g., and more likely to suffer from rolling mill lines and surface imperfections. Such lines must not be tolerated on nave plate material if they are observable after an initial test in the chemical brightener. Experience has shown that neither mechanical polishing nor extended time in the brightening bath will eradicate them. Accordingly, material intended for nave plates that exhibits surface impairment must be rejected on first observation. It is always expedient to carry out acceptance tests in order to avoid wasteful expenditure in time and money by manufacturing and processing unsuitable material.

Spinning

A property of aluminium, which has commended itself to manufacturers since the metal was first produced many years ago, is its ductility and consequent amenability to spinning. Spun material, as compared with pressed material, always gives a better finish since the burnishing effect of the spinning operation closes the surface grain of the material. Illustrations show the method of spinning aluminium nave plates in two stages. The finished plates are then passed to the press section for the piercing of holes by which the component is attached to the wheel or hub. Brightening and anodizing processes are identical with those employed for the radiator grilles.

Current trends in Britain, and also in the United States and in Germany, indicate the popularity of aluminium trim, and a wide extension of its use is to be expected.

Plastics Exhibition

ORGANIZED by our associated journal *British Plastics*, the International Plastics Exhibition and Convention will be opened by the Paymaster General, the Rt. Hon. Reginald Maudling, on June 17. In previous years this biennial exhibition has been known as the British Plastics Exhibition, but the title has been changed because of the now considerable participation by overseas firms. This year, no fewer than 49 out of the total of just over 300 exhibitors are from countries outside Britain; with 18 firms showing, Germany is the most strongly represented country, and Italy comes next with 10 firms.

The exhibition will be open daily, except on the Sunday, until June 27. It will cover 276,000 ft^2 of floor space, and thus is easily the largest in the series, which began in 1951. Within its scope are not only raw materials and processing plant but also a wide variety of finished and semi-finished products. Among the subjects to be discussed at the convention are current trends in the design of plastics articles, foamed plastics and glass reinforced materials.

Provision of Cloakroom and Washing Facilities

THE Factories Act, 1937, requires the provision and maintenance in all factories of adequate accommodation for washing. Specific standards for such accommodation are prescribed in regulations for certain industries.

A new illustrated booklet, "Cloakroom Accommodation and Washing Facilities in Factories",* published by the Ministry of Labour and National Service, seeks to indicate the ways in which the legal requirements in these matters may be met. Guidance is given on such things as location, layout, and types of installation. Suggestions are made on safety from loss or damage, easy deposition and recovery of clothing, space for changing clothing or footwear, and provision for drying outdoor clothing or overalls used in wet processes.

An advisory service is available to employers and others at the Industrial Health and Safety Centre, Horseferry Road, Westminster, London, S.W.1, where exhibits demonstrate how the principles outlined in the booklet have been put into practice.

**Safety, Health and Welfare, New Series No. 5, H.M. Stationery Office, price 2s. 6d. net.*

Sealed Beam Lamps

ON THE 15th May, 1959, British Sealed Beams Limited, a new company with a capital of £1,000,000 was registered. It will manufacture all-glass light units for use in automobile headlamps and in other industrial lamps of similar construction. The factory will be at Corby, Northants., and production of the new unit is expected to begin in twelve months' time. A.E.I. Lamp and Lighting Co. Ltd., the General Electric Co. Ltd., and Joseph Lucas Ltd. are partners in this enterprise.

Manufacture of all-glass light units is carried out on highly specialized automatic machinery, and a large-volume output is necessary to justify the capital outlay and to manufacture at economical costs. For this reason the three companies decided to combine their total requirements in a single manufacturing unit. Considerable technical advantages will accrue from the combined specialized knowledge of the three firms.

The present form of light unit, which is of composite metal and glass construction incorporating a separate bulb, is being superseded in many markets by the all-glass, sealed-beam type which has already been widely adopted in the U.S.A. It is made from two hermetically sealed glass pressings, one being silvered to form the reflector and the other optically constructed to provide the beam pattern. Tungsten filaments are accurately mounted in relation to the glass parts, and the unit design permits improved beam control and longer life of both filament and reflector.

Non-Ferrous Metals Research

A NEW laboratory block has recently been opened at the headquarters of The British Non-Ferrous Metals Research Association in London. This block is the first that the Association has been able to build since the war. Its main features are a large foundry, new corrosion and physics laboratories and a new electroplating shop. In addition, alterations to the existing buildings have permitted the installation of an improved creep testing laboratory and certain other facilities. This rearrangement of the existing building has created a reserve space where temporary equipment can be installed, as necessary, for specific projects. The address of The British Non-Ferrous Metals Research Association is 81 to 91, Euston Street, London, N.W.1.

Analogue Computer

General Purpose Equipment Developed by A. V. Roe and Co. Ltd. for Solving Vehicle Design Problems

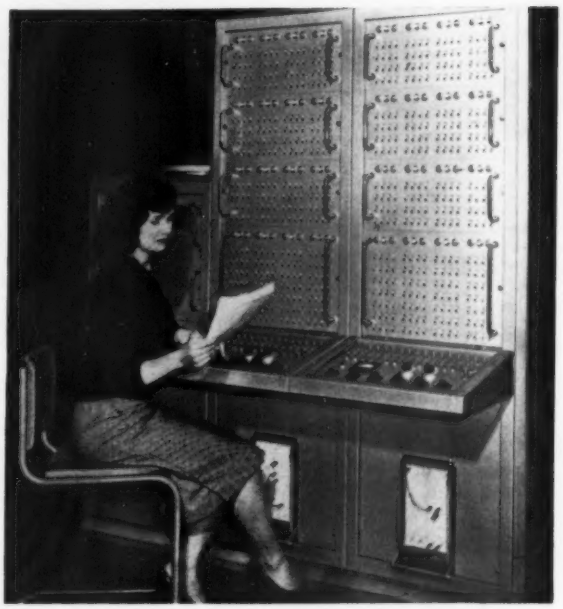
THE electronics laboratory of A. V. Roe and Co. Ltd., a member of the Hawker Siddeley Group which is normally engaged in designing and building electronic computers for use by aircraft and aeronautical engineers, is now prepared to supply computing equipment suitably adapted for the investigation and resolution of problems of motor car design. Of a number of projects suggested, it was decided initially to design and build a computer for solving problems associated with vehicle suspension systems.

Springs, in conjunction with dampers, have to be strong enough to withstand shock loads experienced in the most adverse conditions of speed, road surface and vehicle loading, and at the same time give the most satisfactory ride throughout all running conditions. Tests to find the right combination of spring and damper can involve many months of painstaking work on tracks and roads. Such tests are very expensive and time consuming, and even when completed there is no certainty that all possibilities have been thoroughly explored.

It was because of all these drawbacks to the traditional methods of research that the idea of using an analogue computer has been well received. With this device many design possibilities can be investigated in the laboratory while the vehicle is still on the drawing board. This results in the prototype vehicle having a near-correct suspension system requiring little or no modification.

The computer used in this work is a form of electrical analogue which solves dynamic equations describing the motion of the system in question. The car designer first sets up on potentiometers, electrical values corresponding to such design features of the car, among others, as weight, distribution of load, stiffness of springs and tyres, damper characteristics, rolling radius of wheels, and location of centre of gravity.

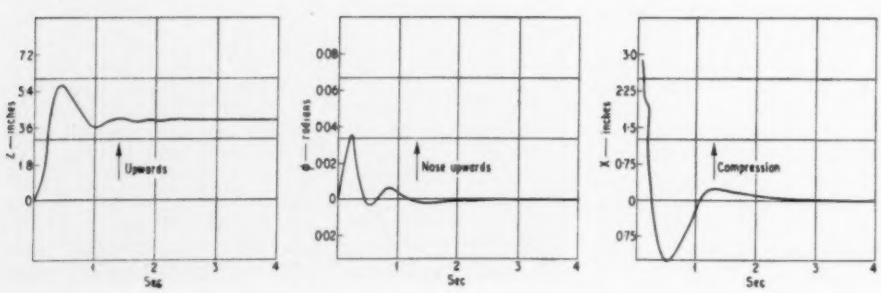
Circuits of the computer are then given an electrical input which represents road surface irregularities. In the case of running up a curb, for example, a 'step' voltage input is applied. Electrical signals then circulate within the computer circuits and the voltages at different points correspond to, and vary in the same way as, dynamic quantities in which the car designer is interested. Such characteristics as pitching, rolling, heaving, tyre deflections, and spring deflections can be evaluated. The results are presented to the operator as a sequence of graphical records fed out of the machine. Typical results of three such investigations are shown on the accompanying illustrations.



The Avro analogue computer

The operator has merely to select on a switch what it is he wants to look at and the machine feeds out the appropriate record. The operator need not be highly skilled. Should the designer wish to explore the effect of changing springs, dampers, or the weight of the vehicle, he has merely to change the settings of one or two potentiometers and repeat the calculations. Thus, in a matter of one or two hours, he is able to assess completely the design possibilities of a suspension system, in contrast to earlier methods involving months of work on road or track. Further, he may also investigate the margins of safety more thoroughly, since there is no danger resulting from trying out unusual design features.

Other interesting possibilities are the study of effects of wear on significant components, and investigations into the fatigue life of the structure. This latter can be done by feeding into the computer, from magnetic tape, varying



Scale replicas of simulator results of response of a large limousine to encounter with a 4 in step at 40 m.p.h. From left to right: Z—body heaving; φ—body pitching; X—proportional to front spring deflection, depending on I.F.S. geometry

signals which correspond to typical road surface conditions which the car is likely to meet. These signals activate the computer and a continuous computation is performed, giving the stresses in the car structure resulting from the roughness of the ride. From this stress record it is possible to estimate fatigue damage, and to facilitate these estimates Avro have developed a fatigue meter for use in conjunction with the computer.

The computer itself does not design suspension systems; but in the hands of an engineer it can be a most useful design tool replacing much experimental work. From the point of view of car stylists, it means that they can get a more sympathetic hearing to their ever-changing demands, since engineers can quickly check the effect on ride and stability when changes in body shape are suggested. Introduction of this type of computer into the motor car industry is only the beginning, for there are many problems associated with engine design, vibration and noise, for example, which ultimately will be handled by computer.

In anticipation of such wider use, the company has developed a computer that is of "general purpose" type, in the sense that by the use of plug-board arrangements the machine can be controlled to perform many varied types of investigation. Many major car manufacturers have visited the Avro laboratory and expressed great interest in the computer work.

Prices will be in a competitive range, it is stated, from about £8,000 for an instrument capable of solving simple problems, and mounting to the region of £22,000 for a computer able to carry out more varied forms of work.

New Plant and Tools

Recent Developments in Production Equipment

THIS three-spindle Barnesdril honing machine is the first of the Model 4014 units furnished with an individually controlled pneumatic hone feed to each spindle. This improved design feature enables the hone feed calibration pressure for each spindle to compensate for varying operating conditions caused by bore irregularities and different degrees of hardness in the workpiece.

Individual feed has resulted in marked improvement in the finished bore characteristics. Taper and out-of-round conditions are less pronounced, and close tolerances on the bore size are maintained by correct control of feed pressure. This pressure control on the honing stones obviates rapid stone wear arising from forced cutting induced by pressure variations between individual tools. The method makes it possible to use coarser stones, for faster stock removal, and yet hold a closer r.m.s. tolerance range.

An automatic feed timer for clean-up of the bores comes into operation when the three bores are sized out and the tools have collapsed, while the spindles continue rotating. Tools are expanded simultaneously under a constant low pressure to the walls of the bores and the timer gives a predetermined number of strokes in order to attain the desired finish. Generally, from three to five are required.

Approximately 0·003 in stock is removed by honing from the fine-bored walls of the cast iron, six-cylinder engine block shown on the machine. By using a three-spindle machine only one indexing movement is required to complete the honing of the block.

Loading from a supply conveyor on the left, the operator slides the block into the tunnel-type fixture and up to a positive stop. It is then clamped hydraulically by pressing the appropriate button on the control panel. Depression of the "start" button initiates the machine cycle to hone and clean-up three bores, index the block to the right, and then hone and clean-up the three remaining bores, without needing attention. The operator then presses the "unclamp" button, slides the block out to a discharge conveyor on the right, and presses the "left index" button to return the fixture to the loading position. Bore finish is maintained at 25-35 r.m.s. and, operating at 80 per cent efficiency, production rate is 32 blocks per hour.

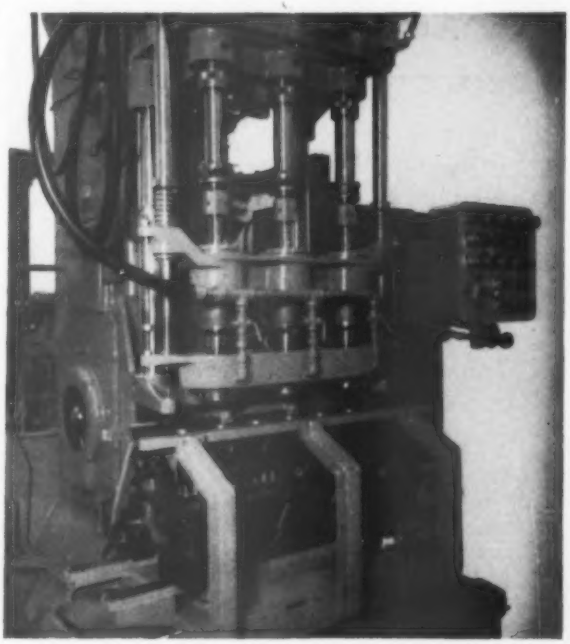
The machine has a 25 in spindle stroke, hydraulically actuated, and is powered by two 15 h.p. motors, one for the spindle drive and the other for the hydraulic system. All Barnesdril machines are handled by Gaston E. Marbaix Ltd., Vicarage Crescent, London, S.W.11.

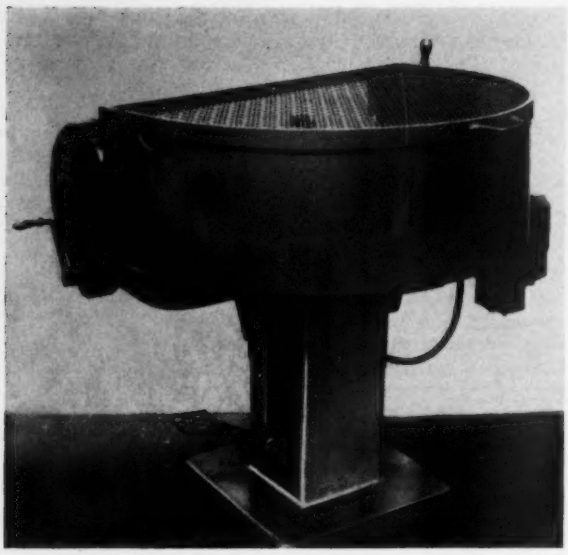
Automatic cold tube-bending machines

New fully automatic cold tube-bending machines, specially designed for the automobile and other industries requiring large quantities of identical bent tubes, have been introduced by Hilgers Maschinen-und Apparate-Bauanstalt m.b.H, Rodenkirchen bei Koln, West Germany. Two machines of differing capacity are produced. Model HyB.70.GV handles tubing up to 2¾ in. outside diameter at speeds up to 450 bends an hour and a smaller unit, Model HyB.50.GV, has a capacity up to 2 in outside diameter and bending speeds up to 600 an hour. Automatic loading tables equipped with magazine feed can also be supplied.

Barnesdril three-spindle bore-honing machine, with individual hone feed. The work fixture provides automatic clamping and indexing

Gaston E. Marbaix Ltd.





Olsen-type cold bend-testing machine. Capacity is up to 2 in steel bar or 6 in wide plate
Edward G. Herbert Ltd.

The machine illustrated, the larger of the two models, is a self-contained unit incorporating hydraulically controlled turntable for bends up to 180 deg, clamping device, positioning device, mandrel bar, and angular turning device. Up to twelve different angles of bend of the same radius, in differing planes, can be bent automatically on a single length of tube. The degrees of angles, position of bends and degrees of rotation can all be preselected by electrical stops which, when set for a particular workpiece, enable the machine to produce automatically the finished bent tube.

After the operator has loaded a length of tube on to the mandrel the sequence of bending is completely automatic. On the angular turning device, collet jaws grip the tube and withdraw it over the mandrel to the preselected position ready for the first bend. The hydraulic pressure slide rail and clamp are actuated and the bending table rotates, bending the tube to the preselected angle required. The clamp disengages, the tube is automatically released from the former and the table returns to zero position ready for the next bend. Then the hydraulic positioning device feeds the tube forward to the pre-set position for the next bend and, at the same time, the angular turning device rotates the tube to a pre-set angle relative to the first bend. The second bend is then made and this automatic sequence will continue for any number of bends up to a maximum of twelve. At the end of the preselected sequence, the finished bent tube is automatically ejected.

The sole selling agent for Great Britain is the Selson Machine Tool Co. Ltd., 41-45 Minerva Road, North Acton, London, N.W.10.

Cold bend-testing machine

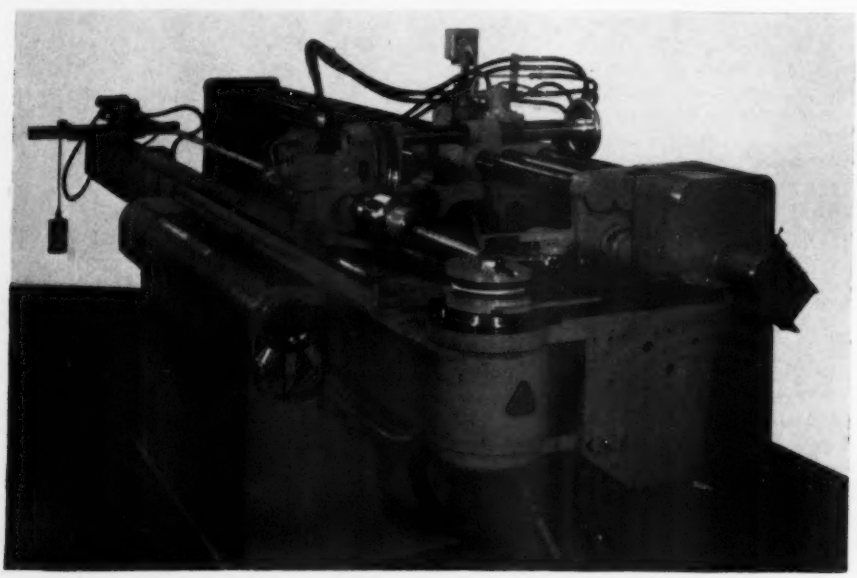
A motor-driven cold bend-testing machine suitable for bending iron or steel bars up to 2 in square or plates up to 6 in wide has recently been built by Edward G. Herbert Ltd., Atlas Works, Levenshulme, Manchester, 19. The specimen to be tested is bent to a maximum angle of 180 deg around a centre pin; five pins of standardized sizes being supplied. The pusher pin is mounted on a substantial table and is readily adjustable in relation to the centre pin so that a perfectly smooth bend of constant radius may be obtained. Around the periphery of the moving table a graduated scale is provided so that the angle of bend of the specimen is continuously indicated throughout the test.

The load is applied by a 5 h.p. motor through a worm-type reduction gear to the table, which is formed of a steel casting. Heavy steel-plate and wire-mesh guards are provided to protect the operator against possible injury arising from fracture of the specimen during a test.

This machine was built under licence from the Tinius Olsen Testing Machine Company, Philadelphia, U.S.A. for which Edward G. Herbert Ltd. acts as sole agent in Great Britain and Eire.

Fluorescent work light

A new addition to the range of Allen fluorescent work lights, designed to facilitate fitting or maintenance work on plant and machinery in cramped and awkward locations, is a model designated Type A.103/G particularly suitable for use in vehicle workshops. It comprises a 2 ft, 20 watt fluorescent tube contained in a sealed Perspex cylinder housed in turn in a heavy-gauge steel reflector. One end



Hilgers fully automatic cold bending machine, to handle tubes up to 2¾ in diameter and 11 ft 6 in maximum length. Twelve stop positions, twelve angles of bend, and twelve angular turning stops can be pre-set for a single tube
Selson Machine Tool Co. Ltd.

of the reflector is attached by means of an adjustable joint to a hollow, cast-aluminium base which houses the control gear. It can be used in, on, under, or by the side of vehicles and the lamp can be positioned to throw light in any direction. Being without heat or glare and casting virtually no shadows, working conditions and efficiency are improved.

This new model meets the requirements of the London County Council under the Petroleum (Regulations) Acts 1928 and 1936, and is very robustly constructed to withstand hard usage in the workshop. The whole unit is sealed and the cable is oil proof. With a tube life of 5,000 hours and a consumption of only 20 watts, running costs are negligible. Standard models are for 200-250 V, 50 c/s A.C. supply, but lights are available for non-standard voltages and frequencies. The manufacturers are P. W. Allen and Co., 253, Liverpool Road, London, N.1.

The Allen 20W fluorescent lamp, suitable for operations under vehicles or plant maintenance in awkward locations

P. W. Allen and Co.

Spray-washing machines

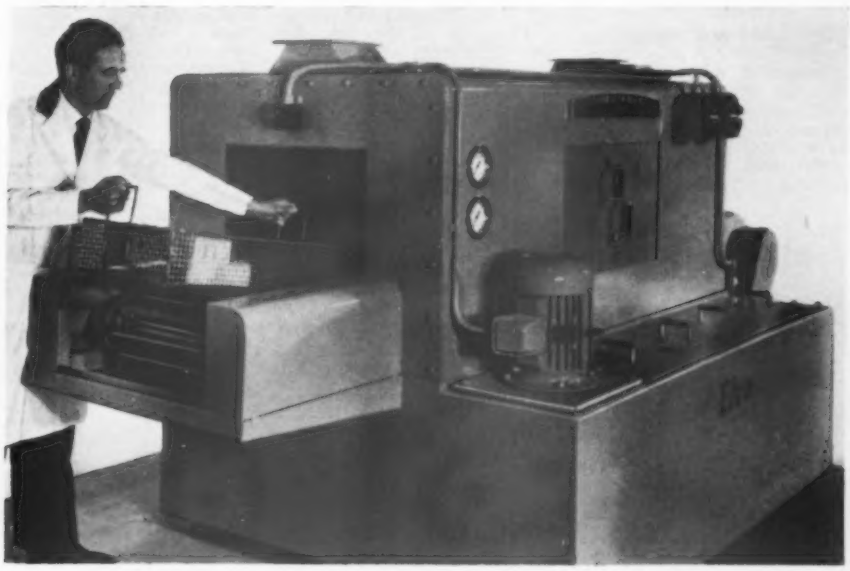
New standardized industrial spray-washing equipment recently introduced by the Electro-Chemical Engineering Co. Ltd., of Sheerwater, Woking, Surrey, includes single-stage and two-stage machines fitted with either mesh-belt, flight-bar or overhead-monorail conveyors. All machines can be supplied with drying sections if required. Particular attention has been given to those design aspects affecting accessibility, maintenance and safety.

In operation, the parts to be cleaned are loaded on to the conveyor and carried through a steel canopy, where they are sprayed from the top, sides, and bottom with pump-circulated cleaning agent delivered through stainless steel nozzles adjusted to give the maximum coverage of the work. Full-width, roller-mounted, sliding doors and a translucent glass-fibre roof hatch improve access to the canopy interior. Vertical monoblock pumps are employed which eliminate external pipework and gland spillage. The two canopy openings are equipped with internal lip extraction ducts, connecting into fume-extraction stubs mounted on top of the machine. Emergency stop buttons are fitted to each end of the conveyor, the drive mechanism of which is fully guarded.

The solution tank is provided with removable covers and a quick-release door, with a space between the tank bottom and the shop floor to give access for hosing down. A quick-filling water service connection is provided, with a float valve to maintain the cleaning agent at constant level during operation. An overflow weir prevents overfilling and enables floating contaminants to be removed from the surface of the cleaning agent. Complete emptying of the tank is facilitated by a sloping bottom and a drain sump.

Pump output is rated to allow solids to settle before recirculation of the cleaning agent, and detachable strainers are provided on the suction side of the pump. Delivery is controlled by a hand valve, and the pressure and temperature gauges are flush mounted in a sealed chamber, which protects them from physical damage and from the ingress of water vapour. Heating is by gas, high-pressure hot water, steam or electricity.

All exposed metal parts of the machine are phosphated and painted with two coats of alkali-resistant enamel. The standard range of sizes includes conveyor widths of 18 in, 24 in and 30 in for the mesh-belt and flight-bar type machines. Variable speed drives, special heavy-duty conveyors, and thermal insulation are available as optional extra equipment to meet specific requirements.



A single-stage industrial spray-washing machine equipped with a flight-bar conveyor. It is one of a range of standardized machines with conveyor widths from 18 in to 30 in. Gas, electric, HPHW, or steam heating is available

Electro-Chemical Engineering Co. Ltd

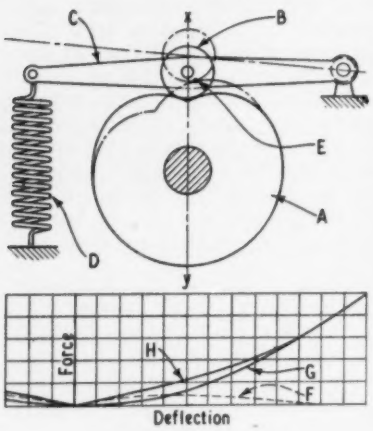
CURRENT PATENTS

A REVIEW OF RECENT AUTOMOBILE SPECIFICATIONS

Zeroing device for steering gear

Every effort is made to reduce the effort required to operate the steering wheel and the full solution of this trend is to resort to power assistance. Such arrangements are admirable on winding roads, in towns, and when parking. At high speeds on straight roads, however, it may be difficult to hold the wheel steady, since for slight angular displacements the effort required is very low and there is virtually no reaction to indicate the alignment of the wheels with the longitudinal axis of the vehicle. To apply springs to each side of the straight-ahead position results in the restoring force increasing with the amplitude of wheel deflection and renders steering more fatiguing.

It is proposed, therefore, to apply a restoring force by a spring operating through a cam device so that it is effective only for a limited angle of wheel movement and disappears with continued movement. A substantially heart-shaped cam A, secured to the steering shaft, is engaged by a roller follower B journalled on lever C constrained by spring D.



No. 798110

As the steering shaft is rotated, the relationship of cam A and follower B is changed and the point of application E of the spring force is displaced from the neutral axis $x-y$, thereby creating a restoring moment. This moment is represented by the curve F. Curve G shows the restoring force between the road and the steerable wheels and curve H the resulting total force when the steering angle is small.

In practice, the cam is active over about 90 deg only on each side of straight ahead; these areas being spiral arcs and the remaining 180 deg a circular arc. If steering wheel rotation is more than 270 deg the cam will again influence the restoring force, but by so little that it is of no consequence. *Patent No.* 798110. *S. A. Andre Citroën (France).*

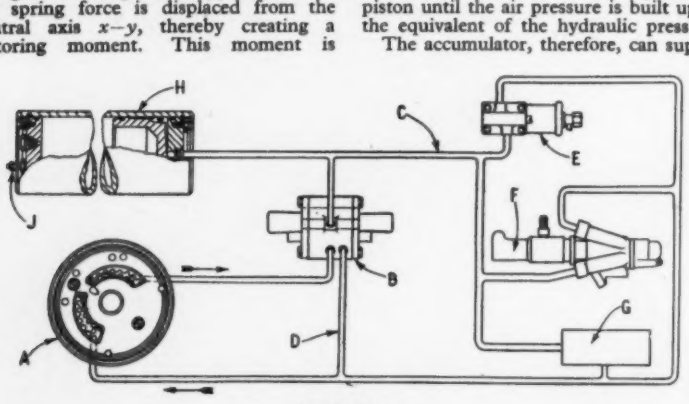
Vehicle hydraulic system

A current trend in vehicle development is to instal an increasing number of power-operated components such as steering devices, brakes, windshield wipers, seat adjusters, window lifts, convertible heads, door locks, boot lids and bonnet lids. Many of these are, or could be, hydraulically actuated and many are provided with a separate power system. In this invention all such components are operated from a common source of fluid pressure, comprising a hydraulic amplifier deriving its input from a low-pressure pump.

Referring to the schematic layout of a suggested system, A indicates a conventional hydraulic pump which may be driven from the engine or, more conveniently, incorporated in the vehicle's automatic transmission unit. Use of a transmission pump avoids the necessity to provide a separate pump or pumps, but the pressure is of the order of 100 lb/in² only. Since considerably higher pressure is required for such items as brakes or steering gear, an amplifier B is provided in the pressure supply conduit. A high-pressure conduit C connects the amplifier to the various components and another conduit D provides a return to the pump.

The high-pressure conduit C supplies pressure fluid to power brake mechanism E, power steering device F and, if desired, other hydraulically actuated components indicated diagrammatically at G. Also connected to conduit C is an accumulator H, of the type comprising a cylinder having a reciprocable piston. The accumulator is precharged, through valve J, with air to a pressure of 300 lb/in² and the introduction of pressure fluid to the opposite end of the cylinder will displace the piston until the air pressure is built up to the equivalent of the hydraulic pressure.

The accumulator, therefore, can supply an instantly available volume of fluid under high pressure to satisfy the initial demands of braking and steering mechanisms. *Patent No.* 801084. *Ford Motor Co. Ltd.*

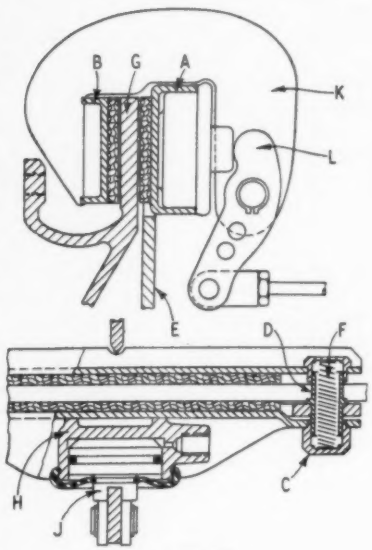


No. 801084

Disc brake

On this brake the pressure plates carrying the friction pads are resiliently mounted from the anchor plate and thus the complete yoke can float to permit actuation by a single pressure cylinder.

Pressure plates A and B, provided with pads of friction material, are furnished at their ends with bushes C for support and guidance on sleeves D mounted on the anchor plate E. The sleeves house springs F which normally space the plates A away from brake disc G. Brake cylinder H, attached to pressure plate A, has a piston having a cylindrical extension J which is slotted and engaged on one arm of yoke plate K. The other arm of this member is engaged in pressure plate B.

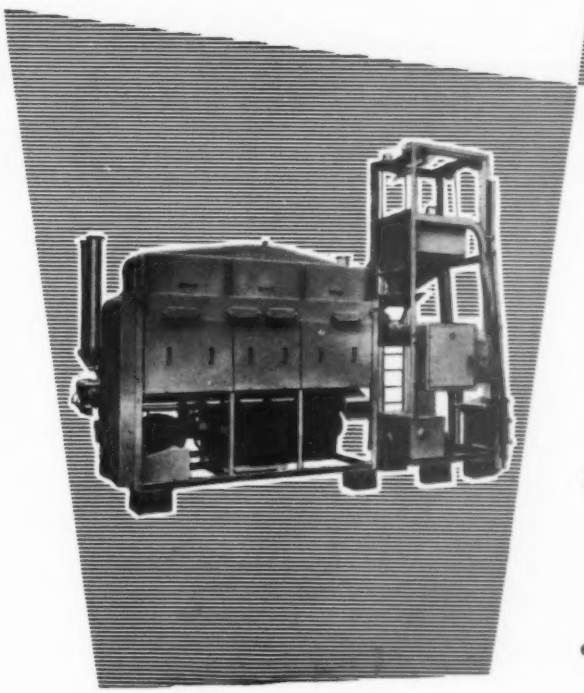


No. 800832

Upon brake actuation, pressure fluid is introduced into cylinder H, the piston is displaced, and the reaction displaces yoke plate K to balance the pressure of the friction pads on opposite sides of brake disc G. When the brake is released, springs F urge the plates away from the disc.

A bifurcated lever L is articulated to the yoke plate for the mechanical actuation of the brake by means of a hand-brake lever (not shown) and a rod in tension. The operative end of the lever bears, at each side of the yoke plate, on cylindrical extension J of the brake cylinder piston. Actuation of the hand-brake lever causes the piston and the brake cylinder to force pressure plate A against the brake disc. The reaction to this force is passed through the fulcrum of lever L and yoke plate K to pressure plate B on the other side. *Patent No.* 800832. *H. Teves and E. A. Teves (Alfred Teves Maschinen-und Armaturenfabrik KG. Germany).*

Washing Bolts and Nuts Down Under



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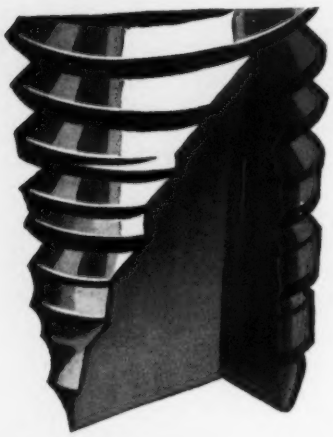

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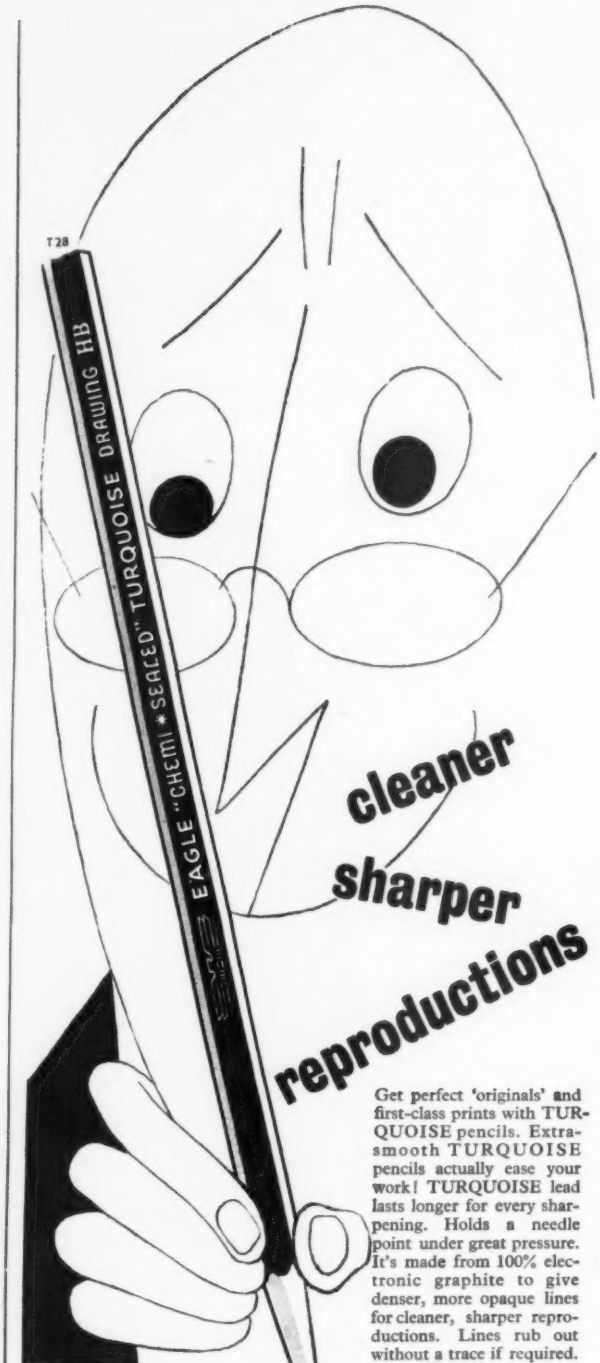

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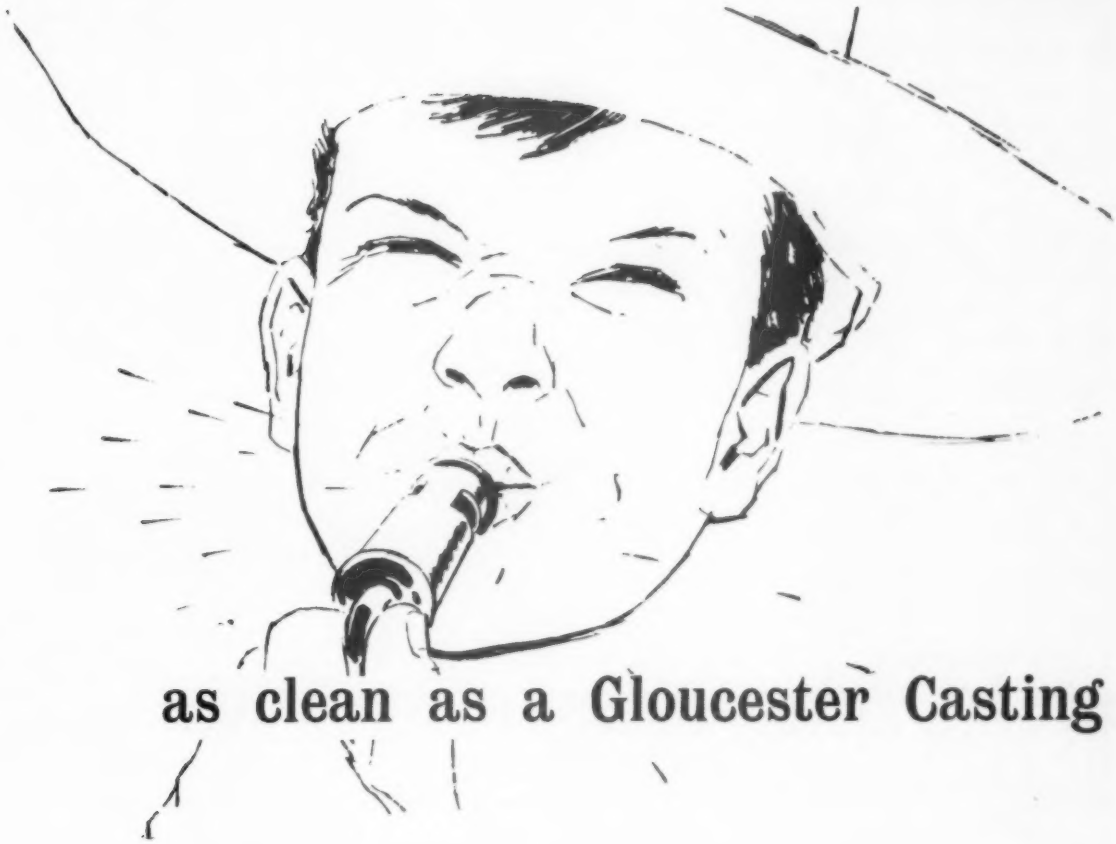

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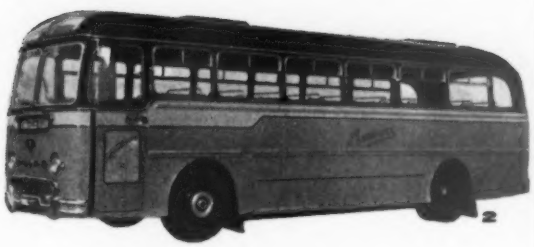

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(Courtesy Duramin Engineering Co Ltd)

2 In this 'Duple' motor coach 'MG5' alloy is used in the form of durable, easily cleaned chequer-plate for flooring, steps and wheel arches. It resists the abrasive wear of scuffling feet, kicks and bumps, and a quick wash over keeps it bright and clean. *(Courtesy Duple Motor Bodies Ltd)*

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4 This Leyland Octopus eight-wheeler is fitted with heavy-duty 'Duraplank' flooring manufactured from 'Duralumin'. This enables it to withstand abrasive, heavy wear and accept loads where weight is concentrated in small areas of the flooring.
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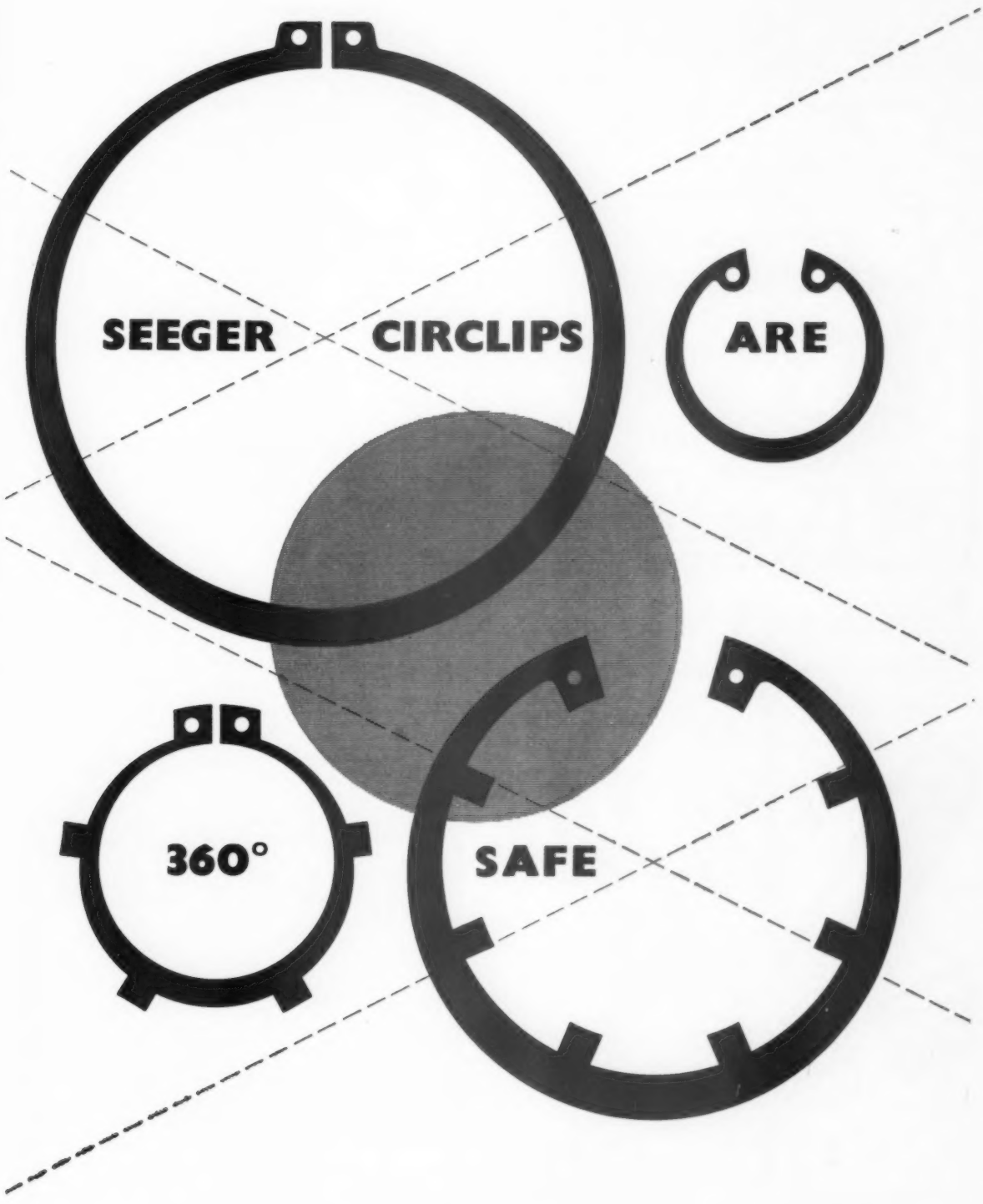

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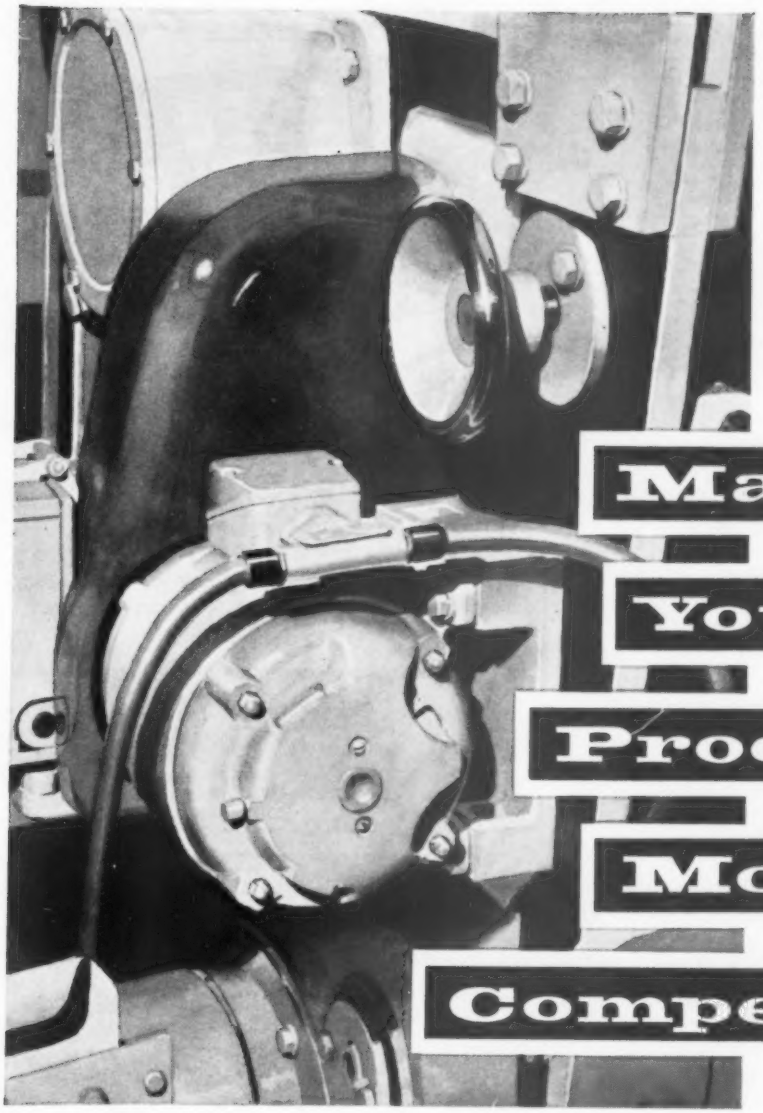

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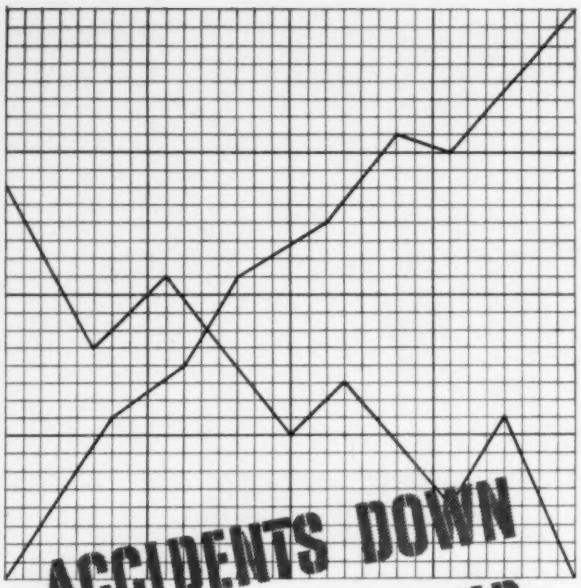

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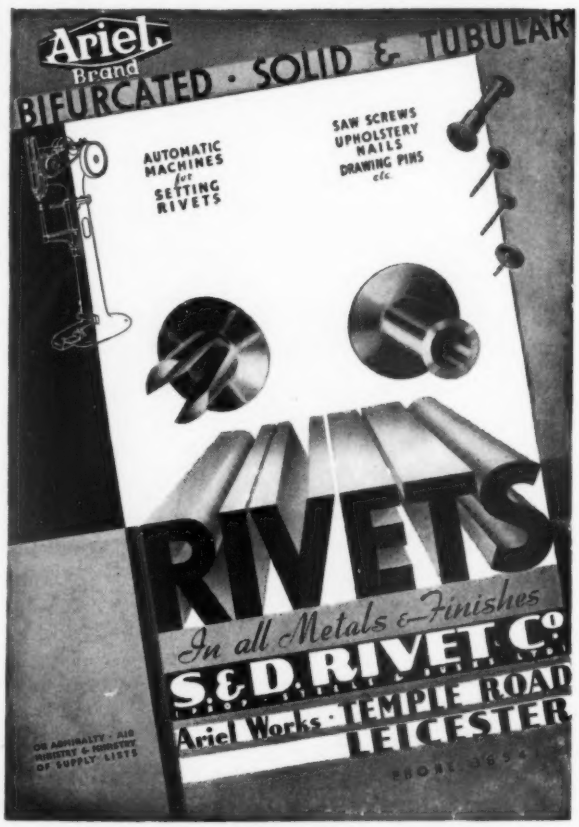

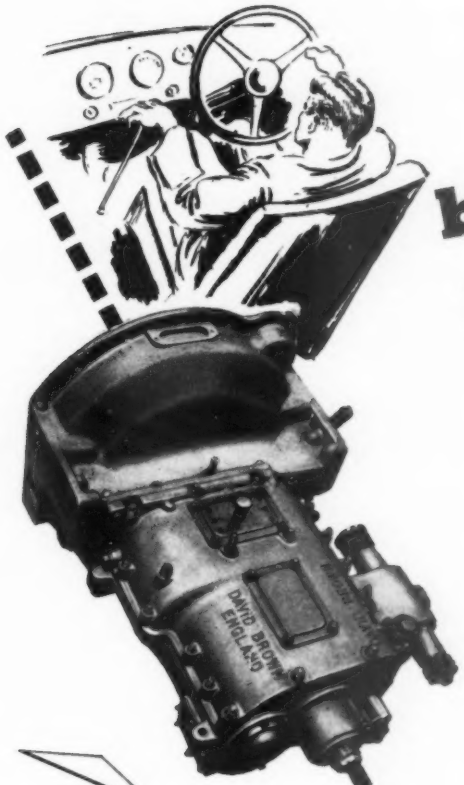

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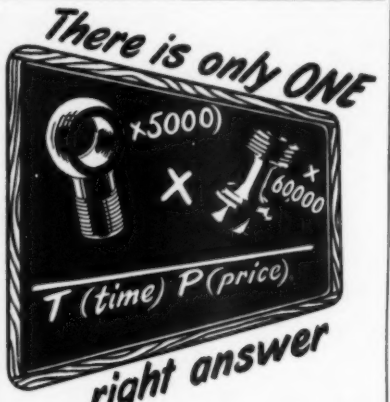

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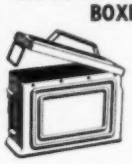

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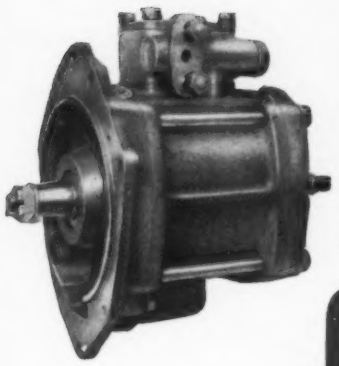

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